

The Spatial Behaviour of Dental Patients in Edinburgh

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Errata for J. McCalden's thesis

1. Page numbers skip from p. 72 to p. 74 so there is no p. 73.
2. Page numbers skip from p. 105 to p. 108 so there is no p. 106 or p. 107.
3. In numbering pages the following diagrams were not accounted for:  
Fig. 3.1, 3.5, 4.3, 6.2, 8.1.

These are purely errors in page numbering. None of the text has been omitted at the points concerned.



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## Abstract

The basic questions tackled are: how does geographic accessibility influence a patient's choice of dentist, and how is this relationship affected by socio-economic factors and mobility? Data on the patient's choice of dentist have been obtained from official dental returns and from a questionnaire survey, and Census data have been used to give a broader picture of the socio-economic character of the areas that patients come from. Methods used to collect these are described in Chapter Three. Previous work on the topic is reviewed in Chapter Two. Chapters Four and Five describe the spatial structure of, respectively, the supply of, and demand for dental care in Edinburgh, and some characteristics of dental patients. The main part of the thesis is concerned with the geographic pattern of distances travelled by dental patients, including an analysis of the 'distance decay' effect in Chapter Six. The effect of other factors and variables, ie. mobility, trip origin and destination, patient loyalty, and surgery capacity are the subjects of the subsequent four chapters. Thus, the different modes of travel used, their effects on distance travelled, and who uses them are considered in Chapter Seven. Chapter Eight is concerned with whether patients with different types of origin and destination have different travel patterns. The factor of patient loyalty is examined in Chapter Nine to determine its effect on distance travelled. To examine the possible effect of surgery capacity and the impact of redistributing capacity a computer model is developed in Chapter Ten; this enables predicted behaviour to be compared with actual behaviour. Finally a summary of the findings is presented together with some methodological criticism of the study and some suggested directions for future research.

## Chapter One

### Introduction

This thesis examines the spatial behaviour of dental patients in Edinburgh: it describes that behaviour and tries to explain its geographic pattern. Two research interests formed the impetus for this study. The first of these was an interest in the location and accessibility of urban facilities. The distribution of a set of facilities automatically distributes a set of accessibility costs and benefits. Consequently, the distribution of a set of facilities is an important influence on the real income of urban residents (Harvey, 1973). Because of this, much research effort has been expended on 'optimum location models' (otherwise known as location-allocation models) and the social implications of their solutions (Massam 1975, Hodgart 1978, Morrill 1965, Dear 1974). Much of this effort has been based on highly simplified and unsatisfactory assumptions about the spatial behaviour of facility users; i.e. it has often been assumed that consumers will simply use their nearest facility. More recently there have been attempts to employ more realistic assumptions by incorporating 'distance decay' exponents as the basis on which spatial behaviour is modelled (e.g. Abernathy and Hershey 1972, Hodgart 1981). However, in both of the latter cases the exponents used were hypothetical and not based on actual behaviour.

Even if empirically derived distance decay exponents were used it must be understood that these are generalisations based on observations of that behaviour, not on an understanding of the behaviour. In other words, distance decay is a symptom of travel behaviour, not an explanation of it.

Therefore, if our knowledge of the parameters of spatial behaviour is

limited, it cannot be concluded that optimal locations produced by optimum location models are, in fact, optimal. There is thus a clear case for enquiry into the spatial behaviour of users of facilities, particularly urban facilities. Such a study could, at least, point to the wider context of spatial behaviour, and may add to our understanding of that behaviour.

The availability of medical care to the population forms the second impetus for this study. In the United Kingdom medical care is available to all through the National Health Service. However, it is not distributed evenly and is not equally available to all. Dental care is one aspect of medical care provision that is of significance to everybody. Tooth decay is virtually continuous though it can be minimised by careful attention to dental hygiene. However, the damage caused by tooth decay can only be put right by a dentist whose job, under the NHS, is to restore patients to a state of 'dental fitness'. Dental disease affects 98 per cent of the population (Todd and Whitworth, 1974) the highest incidence for any disease (Court, 1976). Throughout the United Kingdom it accounts for five million working days lost each year and contributes to seventy thousand episodes of illness annually for which sickness benefits are paid (Meacher, 1973). In 1975 the cost to the exchequer of the General Dental Services alone was £130 million (Trainer, 1976). During the same year 2.5 million courses of treatment were carried out by 1189 general dental practitioners in Scotland (SDEB). Thus dental care is of some importance to the NHS and to the general public. There appears, so far, to have been very little work on the geographic patterns of use of dental care, despite its importance to the general

public. This importance was a factor in the selection of 'dental care' as the context within which spatial behaviour was to be considered.

The general dental service is the focus of this study because it is available to the general public and is distinct from the school dental service, the hospital dental service and the community dental service, the latter providing dental care for the elderly, pre-school children, and nursing and expectant mothers.

General dental practitioners are free to locate their surgery wherever they choose, subject only to planning regulations. Because the distribution of a set of facilities confers a set of accessibility costs and benefits to its users, and because of the high cost to the exchequer of providing the General Dental Service, dentists are, in a very real sense, redistributing income through the siting of their surgery. However, a redistribution of income would occur even if the general dental service were completely unsupported by exchequer funds. Patients pay to travel to their dentist - directly by way of bus fares, petrol and car parking; and indirectly through travel time and the opportunity cost of that travel time. It is possible that the cost may be too high for some people and may actually reduce or curtail their use of this service. The result would be poorer dental health. On the other hand, some patients may travel right across Edinburgh to attend the dentist of their choice, regardless of the cost.

Given the two reasons for undertaking this study the basic question



addressed by the thesis becomes 'why do patients attend the surgeries they do?'. Clearly, answers to this question could be of great importance in planning the provision of dental care. Though the service is not 'planned' local health authorities may influence the distribution of dental care by providing information to dentists who are considering where to open a surgery. Such information could comprise a general description of the population, of the distribution of the existing surgeries, and an analysis of how much demand surgeries at selected sites might enjoy. In addition, the local health authority could provide facilities and create salaried posts in areas that were considered to be underserved<sup>1</sup>.

From the point of view of the dentist it is necessary that his surgery be situated so as to attract sufficient volume of demand to ensure an adequate income. Viable sites could include some that dentists may regard as quite unlikely locations. For example, large council estates may generate a lot of demand for dental care, even though people who live in council estates may have a low propensity to attend a dentist. The reason is simply that large, high density populations may still provide a lot of infrequent attenders and 'hard core' regular attenders within easy reach of a centrally sited surgery.

Without a more detailed understanding of 'why patients attend the surgeries they do', better provision of dental care may never be achieved - 'better' in the sense of easier to get to for the patient, ensuring an adequate income for the dentist.

A Ph.D. project such as this cannot undertake a completely definitive study of the spatial behaviour of dental patients. Because of limited resources and experience this study should be seen rather as an exploratory study of some questions concerning spatial behaviour. In particular, it focuses on describing this behaviour and considering some of the reasons that may account for it. The structure of the thesis is defined by those factors which have been considered as possible explanations.

Essentially, the thesis comprises four parts. Part one consists of Chapters Two and Three, which describe the context within which the analysis has been conducted. In Chapter Two previous work on the spatial behaviour of medical patients is considered. This work was used as a basis for selecting the questions covered by the thesis. In general, the approach adopted was to acknowledge that dental patients do not necessarily attend their nearest surgery, and to examine some possible reasons for this. Four particular aspects were chosen: how do mobility, journey origin and destination, loyalty, and surgery capacity influence the distance travelled? Chapter Three describes the methods used to collect the data required to satisfy these <sup>b</sup>objectives. Four sources of data were used and the suitability and quality of each are assessed.

The second part of the thesis (Chapters Four and Five) describes the spatial structure of supply and demand. In Chapter Four the distribution of dental surgeries is described. Some implications of this for the accessibility of dental care for the population generally and for selected sub-groups are examined. A profile of the

population of dental patients is given in Chapter Five. In particular details are presented of where they live and how they compare with the general population in terms of certain demographic characteristics. An assessment of the propensity for people in various population sub-groups to be dental patients is also included.

The main concern <sup>of</sup> ~~ot~~ the third part (Chapters Six to Nine) is to analyse the spatial behaviour of dental patients. Chapter Six describes the spatial behaviour of dental patients in Edinburgh. First, the geographic pattern of distances travelled to the dentist and the 'distance decay' effect are examined. Comparisons between patient sub-groups are then made.

In theory, a dental patient can attend any surgery he chooses. In practice, however, distance is a barrier to choosing the more distant surgeries. Throughout the thesis the term 'spatial choice' is used to describe the extent of 'choice' of surgery actually exerted, in the sense that travel costs have been incurred and other surgeries by-passed. Thus longer distances travelled imply a more actively asserted choice in as much as higher costs are borne and more accessible surgeries by-passed; a short distance travelled represents a stronger tendency to comply with the basic geographical factor of distance.

The remaining chapters in this third part are concerned with why there are differences between patients in the spatial choices they make. Personal mobility is considered in Chapter Seven. Various modes of travel for the journey to the dentist are used by patients.

each has a different ability to overcome the 'friction of distance', and hence to permit a lesser or wider spatial choice.

One of the assumptions commonly used by optimum location modellers is that users of a facility will travel from their home. Clearly this may often be an unrealistic assumption. Most activities outside home are undertaken serially. That is, a shopping trip will usually incorporate visits to several shops, one after the other. It doesn't make sense to go home in between. In the same way, a visit to the dentist may originate from a location outside the home. The destination afterwards may also be somewhere other than home. In Chapter Eight work, shopping and school are considered as alternative origins and destinations.

A patient's loyalty to his dentist when he moves house to a more distant part of the city may cause him to travel relatively long distances. An analysis of the temporal and spatial components of patient loyalty is given in Chapter Nine.

Part four of the substantive analysis is contained in Chapter Ten. This is mainly a theoretical appraisal of the role of surgery capacity in causing patients to attend surgeries further away than their nearest surgery. Basically, the notion is that 'one cannot fit a quart into a pint pot'. Thus, where the capacity of a surgery is insufficient to meet local demand, some of that demand must look elsewhere for dental care - for instance, to the next nearest surgery with spare capacity.

A summary of the results of these various analyses is presented finally in Chapter Eleven. Pointers for future research on the topic, together with methodological lessons learned from this work are also discussed.

### Notes

1) Ian Maddick, Chief Area Dental Officer for Hampshire suggested this method for local health authorities to influence the distribution of dental surgeries.

## Chapter Two

### Distance and the Use of Health Care Facilities:

#### A Review

To 'focus attention' on considerations most appropriate to a study of the spatial behaviour of dental patients in Edinburgh it is necessary to seek guidance from previous work. That is the task of this chapter. As noted in Chapter One, a basic stimulus to this study was the desire to gain more understanding of the behaviour subsumed within the distance decay exponent of location-allocation models. Accordingly, this chapter concentrates upon literature dealing with the relationship between distance and the use of medical care facilities. Various aspects of that relationship are discussed and these are used, at the end of the chapter to set the avenues for exploration by this study.

Distance is the basic geographic fact that has most commonly been associated with the use of medical care facilities and Shannon, Bashshur and Metzner in 1969 reviewed the American literature concerning the relationship between distance and the use of health care facilities. They noted that the treatment of 'distance' as a factor of significance was quite increasingly sophisticated. In the 1920s it was recognised that use of physicians' services decreased as distance of the place of residence from the physician increased. Also, it was concluded that rural residents would have difficulty obtaining care because of the long distances involved and the relative shortage of physicians in rural areas. However, distance was not the focus of these early studies. Only during the 1930s was distance considered explicitly, but Shannon et al, drew attention to the limitations of this early work. First, the studies of this period were all of rural areas and thus less relevant to the contemporary population of most of the USA. Second, the measures of distance were



crude and of low resolution being between the mid points of towns and thus more or less excluding intra-urban measures. Finally, the practice by physicians of making home calls on patients was not adequately accounted for in these studies. The findings of this period of research are not surprising: patients in rural areas had to travel 8-10 miles, on average, to see a physician; residents of rural areas travelled longer distances to see a physician than did urban residents; and the 'decay' nature of rates of utilisation was not associated with variation in rates of illness, i.e. patients who lived relatively far from a physician would call upon his services less, even though their rate of illness was similar to that of patients living relatively close to the physician.

Following the end of World War II the Hill Burton legislation of 1946 (to help States provide adequate medical care for their populations) generated new research into the distribution of facilities. However, problems concerning the distribution of medical care facilities in urban areas were still not considered the most urgent. Nevertheless, studies of the initial post war period began to deal with such topics as the delineation of medical service areas, the effect of socio-economic factors, the introduction of mathematical approaches and intra-urban travel patterns.

It is interesting to note that Shannon et al, do not review any more studies of the use of medical facilities after this early post war period. From the early sixties attention appears to have switched from the spatial behaviour of patients to the planning and modelling of health care systems. In conclusion they noted that distance was

used as a surrogate for '... the human phenomena which are involved in travel.' Consequently they called for a widening of the concept of distance as used in medical care research.

Thus in 1969, though there had been much research on the relationship of distance to aspects of the use medical care facilities, Shannon et al., were clearly not satisfied with the improvements made to our understanding the spatial behaviour of patients. Consequently, they suggested some directions for research:

- a) a deeper examination of the effect of distance on 'medical activities';
- b) an expansion of studies of the use of medical care in urban areas to consider the relationship between "medical care activity" and "... the urban-space utilization patterns of social contacts in informal and formal associations."

The latter approach would be concerned with how the use of medical care facilities relates to other aspects of spatial behaviour within the city. The remainder of this chapter will mainly consider to what extent subsequent work has followed these directives.

The strongest emphasis in more modern literature has been the consideration of the relationship between distance and the pattern of use of medical care facilities. When discussing the ways that distance can influence the delivery of health care Abernathy and Schrems (1971) noted two effects it can have:

- a) '... as a barrier to access to care ... particularly [for] ethnic minorities, poor, elderly and rural subpopulations.'

b) '... in the user's choice among different facilities.'

In other words, distance, at the very least, will influence a patient's choice of health care centre and, where distances are relatively large or mobility is poor, it may reduce overall demand for health care. Abernathy and Schrems found, in a study of the use of primary care by families living in a region of California's San Joaquin Valley, that demand was 'elastic' for only one population sub-group, out of ten considered. (In a geographic context, the term 'elastic demand' concerns the notion that demand for a service declines as distance from the point at which the service may be obtained, increases). The measure of distance used was the travel time from the mid-point of the census tract in which the family resides to the nearest primary care unit. On this basis rates of use were associated with distance (travel time) only for migrant Mexican-Americans and short term residents. It would appear, therefore, that spatial elasticity of demand is not a general phenomena but may be found in particular sub-groups of the population.

On the other hand Abernathy and Schrems (1971) note that they found strong evidence for distance influencing the choice of primary care centres. The further away a family lived from a primary care centre the less likely they were to use it. There were, however, variations in the strength of this effect. To the authors it appeared that for social groups with the security of higher status and income the overriding factor was convenience. Consequently, these groups were least likely to attend more distant centres. On the other hand, for ethnic minority groups, distance to primary care centres gave way to the

importance of familiarity and social ease that particular centres offered. Hence, they were more likely to travel longer distances in order to obtain the 'quality' of care they desired. However, it should be noted that this type of behaviour may be unique to the USA because of its wide diversity of ethnic groups.

In general, the literature follows the emphasis, identified by Abernathy and Schrems, on the effect of distance on choice rather than on overall rates of use. Russell and Holohan (1974); Ingram, et al., (1978) and Roghmann and Zastowny (1979) have considered the effect of distance on choice of hospital emergency departments. In a study in Newcastle upon Tyne of patients suffering from minor trauma Russell and Holohan concluded that distance was the major influence on whether a patient would attend a hospital emergency department or his general practitioner as his initial choice of entry to the medical care system. The GP could, of course, subsequently refer the patient to a hospital. From the figures they present it appears that, with regard to the decision to seek care, the more distant a patient from his GP the less likely he is to seek care from his GP, and the more likely he is to go to hospital. Conversely, the further away the hospital the more likely the patient is to attend his GP.

Ingram et al studied the effect of distance on the decision by patients to visit the emergency department of Humber Memorial Hospital, located in north-west Toronto. They found a clear exponential distance decay curve away from the hospital, thus demonstrating that distance has a strong influence on this decision. A quarter of patients stated that they made their choice because the

Humber Memorial Hospital was closest in distance or time, whilst over half based their choice on the influence of a doctor or on a previous association with the hospital. These findings are salutary in two respects. First they reinforce the view that distance is an important determinant of choice. Second, the extended tail of the distance decay curve and the reasons given by respondents for their choice of hospital remind us that factors other than distance can influence spatial behaviour. In other words, distance can be a dependent variable (symptom) as well as an independent (causal) one.

Finally, Roghmann and Zastowny considered 'Proximity as a factor in the selection of health providers ...' in Monroe County, New York State. They compared emergency care with obstetric admissions and abortions. Their statistical analysis of the use of the six hospitals in Monroe County for these purposes led them to the following conclusions:

- a) distance influences the 'frequency of utilisation' as well as choice of hospital;
- b) the effect of distance varies with the characteristics of the hospital and the population served;
- c) the effect of distance varies with the services sought and the accessibility of alternative sources of care;
- d) emergency room visits showed signs of being influenced by previous contacts at the given hospital.

This last finding concurs with the results of Ingram et al that factors other than distance are important determinants of choice, and particularly of previous contact with the health care system.

Perhaps the most interesting conclusion of this study is that 'frequency of utilisation' is influenced by distance. This appears to mean that demand is spatially elastic. Such a conclusion is important enough to warrant detailed consideration. It should be pointed out immediately that spatially elastic demand would show a variation with distance in the 'rate' of use per 1000 population in different areas, or some other standardised measure. However, in this case simple 'frequency' of use was used instead. The regression model used was of the form:

$$ER_i = a + b_1 d_{ij} + b_2 SES_i + b_3 POP_i$$

where

$ER_i$  = the number of emergency room visits generated by neighbourhood  $i$

$d_{ij}$  = travel time, in minutes, from neighbourhood  $i$  to hospital  $j$

$SES_i$  = average socio-economic standing of the population of neighbourhood  $i$

$POP_i$  = population size of neighbourhood  $i$

and was associated with a correlation coefficient of 0.633. Of the forty per cent explained variance, six per cent was due to the influence of distance. Thus, though distance may be significant, it is of relatively small importance as an individual determinant of the number of emergency room visits from neighbourhood  $i$ .

In addition, the analytical design used by this study does not directly focus attention on the question of spatial elasticity of demand. A more appropriate design would have used the 'rate' of use (e.g. patients per thousand) as the explicit dependent variable and tested whether it varied with distance whilst other variables such as

socio-economic standing were held constant. The design used here simply demonstrates that  $ER_i$  varies with distance, population and socio-economic standing, together. Finally, and most importantly, alternative suppliers of emergency care (physicians) have not been considered. Therefore, it is quite possible that demand for emergency care is simply being redirected to this alternative source. It would appear that if 'frequency of utilisation' was meant to suggest that demand is spatially elastic, that such a claim receives little support from the evidence presented. Furthermore, if demand which is far from <sup>a</sup>hospital is being redirected to alternative sources of care, this would reinforce the finding of Russell and Holohan that distance from care influences the type of service at which care is sought rather than reducing the volume of demand for care.

From this brief review of only three articles, it appears that the call by Shannon et al for a 'deeper examination of the effect of distance on 'medical activities'' has not yet been answered. Studies in this area tend to suffer from a very simplistic approach to the role of distance, weak analytical designs and overstatement of findings. In order to conduct a deeper examination of the effect of distance it is necessary to consider in some detail what those effects might be. The fact that distance influences choice, and the nature of that influence, have long been known. Of course all studies have to check that this influence is present in the phenomena under study, but to stop at that point is hardly more than mere repetition. Also, whilst spatial elasticity is quite a straightforward concept, identifying its presence or absence with any degree of certainty demands a rigorous approach to the formulation of the research



design, the collection of data and the analysis. Such rigour has been largely absent from the literature to date.

Besides influencing spatial choice, distance has been shown to exert other influences on the spatial behaviour of patients. An interesting example of this type of work is that by Girt (1973). He argues that distance from medical care will influence the patient's behaviour with regard to the maintenance of health and the avoidance and elimination of ill-health. In certain circumstances this influence may confound our expectations from previous works: '... increasing distance from a physician up to some limiting distance may actually encourage rather than discourage the individual to consult when he feels sick.' As distance from a doctor increases, an individual may feel more 'sensitive' to the development of disease and thus be more likely to attend a doctor at an earlier stage in that development. On the other hand, the effort required for travel and the associated opportunity cost mean that '... therapeutic behaviour is likely to be negatively affected by distance'. That is, distance is likely to become a barrier to obtaining care as distance from the source of care increases. Girt found, from questionnaire data, that patients did tend to be more sensitive to ill-health as distance from care increased. Also, there was some evidence that readiness to consult initially declined with distance but eventually showed an increase. This finding, however, was somewhat tentative. With regard to therapeutic behaviour the questionnaire data did suggest declining use with increasing distance. Using actual 'consulting' data Girt did, however, demonstrate that the preventive consulting behaviour postulated (above) was reflected in the data, though there were



variations between patients suffering different types of illness.

The certainty of these findings, based mostly on a statistical analysis of questionnaire data, was admitted by Girt to be low. Two other methodological weaknesses should also be noted. First, the questions asked were of a hypothetical nature, e.g. 'suppose you had the following complaints ...' Hence, these findings are further reduced to a dependency on the unknown relationship between questionnaire responses and actual behaviour. Second, the context of his study was Newfoundland. The distances used were those between seven settlements and three cottage hospitals, where free access to physicians for general medical treatment was available. Unfortunately, Girt does not tell us whether alternative general medical care was available, though it is unlikely, in any event, to have been widely available in this rural situation.

Another study illustrating the more complex side of distance as a causal factor is that by Weiss and Greenlick (1970) in Portland, Oregon. They identified four ways in which initial contact with a medical care system can be made:

- a) by telephone,
- b) by appointment,
- c) by an unscheduled 'walk-in',
- d) by use of a hospital emergency room.

The objective of their study was to identify variations in the type of initial contact with variation in social class and residential location. Members of the Kaiser Foundation Health Plan formed the study population (115,000), which comprised approximately fifteen per

cent of the Portland Standard Metropolitan Statistical Area population. From this population a sample of 3106 was drawn and classified by social class and distance from the nearest Kaiser Foundation facility (3 clinics and 1 hospital). One of the advantages to a researcher of the American free enterprise system of providing medical care, through pre-paid group practice organisations, is that study populations are reduced in size. Members of the Kaiser Foundation, by virtue of being such members, are effectively isolated from alternative sources of care. Thus, use of data from such health plans provide a simplified means of considering whether or not demand is spatially elastic. This does not appear to have been recognised by Weiss and Greenlick. Nevertheless, from their sample they did not find any regular association, for members of the health plan, between increasing distance and decreasing contact with the medical care system for either the middle or working classes, even though distances of up to twenty miles were involved. Thus, the authors, somewhat inadvertently, provide evidence indicating that demand is not spatially elastic. On the other hand, and as might be expected, they did find that the number of members of the health plan declined with increasing distance. This undoubtedly indicates that, as the distance that people live from Kaiser Foundation facilities increases the less likely they are to be members, and the more likely they are to be members of alternative health care plans with more accessible facilities.

Thus distance influences choice, but this influence is itself modified by social class. For example, Weiss and Greenlick found that relatively more of the working class members (58%) were to be found

within five miles of a Kaiser facility than was the case for the middle class (49.8%). Conversely, in the three succeeding distance bands (up to twenty miles) there were relatively more middle class members than working class. In other words, the distance decay curve reflecting the desire to be members of the Kaiser Plan was steepest for the working class. This could mean that they suffered the greatest 'friction' of distance effect. Alternatively, this distribution of social classes may simply reflect the structure of North American cities. Clear differences between the middle and working classes were identified in terms of the ways they initiated contact with the care system. For example, the middle class generated 49 telephone contacts per hundred middle class members compared with only 26 contacts per hundred working class members. In addition, there were 62 walk-in contacts per hundred middle class members compared with 50 per hundred working class members. With regard to distance Weiss and Greenlick showed that for the middle class it had no effect on their use of walk-in or emergency room contacts, but that beyond fifteen miles appointments fell off whilst telephone contacts increased. For the working class the walk-in contacts appeared to decrease with increasing distance, especially beyond fifteen miles. However, emergency room contacts increase sharply at this point. Also, the working class were found to prefer walk-in contacts to appointments at distances of less than ten miles, but beyond this distance the reverse was true. Thus, as distance increases, the working class person appears more likely to accept an appointment.

Generally, the explanation for these variations between the classes

was thought to lie in the fact that middle class people are more articulate than working class people and hence more ready to use the telephone to initiate contact, especially if the distance to the nearest facility is relatively great. The working classes, on the other hand, are more likely to delay making contact until they are sure they require help. At this point, because of their poorer articulatory contact is made through either the walk-in or emergency room modes rather than by telephone. However, following Girt's notions on the effect of distance on preventive behaviour, it would appear that the working class do become more sensitive to ill-health as distance from care increases and are thus more likely to initiate early contact by means of an appointment, before the symptoms become more pressing and demand immediate attention.

Overall, the study by Weiss and Greenlick makes two general points:

- a) distance has a clear impact on choice. By choosing the Kaiser Foundation Health Plan in the first place. And by the method of initial contact with Kaiser facilities;
- b) middle class members appeared to make more use of the facilities available to them than did working class members.

As suggested earlier, distance need not always be considered as the independent or causal variable. A general impression from much geographic literature is that distance is almost always considered a causal variable capable of explaining most, if not all, of the spatial variation of the phenomena under study. When levels of explanation fall short of this standard, 'excuses' are presented which may, for example, claim that measurement error or the use of an

inadequate model was the cause. Very rarely is it recognised that distance is only one of many factors which may influence spatial behaviour and that this influence may operate in a complex manner with other factors. There are, however, some studies which concentrate on the 'dependent' aspect of distance and thus demonstrate that distance is not King!

Morrill, Earickson and Rees (1970) have shown in Chicago that a number of factors can influence the distance a patient travels to hospital. The most direct influence on distance travelled is the physician. Physicians tend to affiliate with only one or two hospitals and they can refer patients only to those hospitals with which they are affiliated. Thus, once a patient has chosen a physician the choice of hospital is out of his control and already largely determined. However, the authors provide three reasons why patients need not necessarily choose the nearest physician:

- a) patients may prefer physicians located in business centres, especially the CBD, in the belief that such physicians are more highly qualified than local physicians;
- b) the supply of nearby physicians may not be sufficient to meet local demand;
- c) patient loyalty - patients may continue to attend a particular physician even though they or the physician have moved away.

Besides the impact of physicians, Morrill, and co-authors, considered the effects of race, religion and income on patient-to-hospital distances. Generally, the story they unfold is one of prejudice, of

both supply and demand. On the supply side few hospitals admit all patients. But it was found that several hospitals in black areas admitted relatively few blacks, in terms of the population mix. The effect was that black patients travelled twice as far (6 as opposed to 3 miles) as they would if they had used the nearest hospital. Besides racial prejudice by the hospitals, physicians themselves do not tend to locate in black neighbourhoods. Thus blacks have poor access to physicians. This was attributed by the authors as being, perhaps, part of the reason why black patients delayed seeking care until their symptoms became serious. Consequently, many black patients try to enter hospital directly. However, the only hospital which normally allows such admissions is Cook County Hospital. Some other hospitals will admit black patients if their cases have teaching value, but in the absence of this 'attraction' many black patients must travel long journeys past potential intervening facilities to receive care. Income, of course, is also an important barrier to entry to the health care system. Under the North American free-enterprise system very few hospitals can afford to provide more than a limited amount of free care. The result is similar to the effect of racial prejudice, namely long journeys for the poor past more accessible facilities. Indeed, to a large extent the problems of poverty and race are coincident, with a large proportion of the poor being black.

On the demand side a similar type of prejudice exists. Some blacks seek black physicians and black hospitals, but the phenomena is best exemplified by the impact of religion. The authors hold that religious preference modifies the perceived attractiveness of and

distance to hospitals. Patients influenced by religious considerations may thus travel relatively long distances past hospitals which, to them, are not intervening opportunities, to the hospital of their choice. Such considerations are perhaps most important to Jewish patients, due to their dietary requirements. Patients living in Jewish residential areas were found to travel unusually long distances. A similar effect was observed for patients from Catholic residential areas. Because more hospitals catered for Catholic patients, however, the effect on distance was weak. Thus race, income and religion were identified as important factors influencing the distance travelled by patients to hospital in Chicago.

Findings similar to those of Morrill et al, concerning the effects of race, income and religion on the spatial behaviour of patients were also found by Bashshur, Shannon and Metzner (1970) in their study of the use of various health care facilities in Cleveland, Ohio. They focused on travel patterns to medical care facilities in order to determine the extent to which people use the facilities closest to their homes. The facilities chosen were hospitals, physicians, dentists and pharmacies, and the data were obtained from a questionnaire survey of a sample of respondents representing the adult population of the Greater Cleveland metropolitan area. Besides the findings alluded to earlier, Bashshur et al noted that the decentralisation of the population relative to hospitals resulted, not surprisingly, in travel directions which tended to be in towards the city centre and that distances travelled were longer for suburban respondents than for those in the city centre. However, a less

obvious finding was that the distances travelled to suburban hospitals were shorter than to centrally located hospitals. They noted that this was the case irrespective of the size of the hospital.

This latter point is somewhat surprising. Sumner (1971) and the Research Unit of the Royal College of General Practitioners (1973) have noted that large surgeries (in terms of the number of doctors) are associated with longer journeys to the doctor, because the concentration of doctors in large surgeries means there are fewer surgeries. That longer distances do not seem to have been travelled to large suburban hospitals in Cleveland suggests that (other factors such as physician referral practices, racial prejudice, etc., being equal) the overall shortage of supply of hospital care, relative to demand in these areas, ensures that local hospitals treat only local demand, whilst any excess demand is re-directed to the 'hospital rich' city centre. Travel patterns to physicians showed a considerable degree of variation (in terms of distance) along lines that would be expected, given the influence of race, income and religion. Travel to the dentist, however, showed much less variation between population sub-groups. No explanation of this fact was presented, though it would appear that the preceding factors are less influential when it comes to dental care.

A more detailed analysis of the behaviour of black patients has been undertaken by Shannon, Spurlock and Bashshur (1975) and Shannon and Spurlock (1976) in Washington, DC. Shannon et al, considered the differences in 'health seeking behaviour' related to socio-economic status in two black communities, one comprising mostly residents of



low social status and the other mostly middle class residents. In the former community it was found that relatively more of the low status respondents (86%) sought care at hospital outpatient or emergency departments than did middle class respondents (21%). Conversely, many more middle class patients (50%) obtained care from a private physician than was the case for lower status patients (38%). In association with this more extensive use of private physicians, middle class respondents utilised a wider range, and more widespread range, of physicians and travelled longer distances than did low status respondents. Patients from the largely middle class area showed less marked behavioural differences between the social classes. Low status patients in this area were as likely to use private physicians as were middle class respondents from the low status area. The general conclusion from this work was that in largely lower class areas there is a marked difference in health care seeking behaviour between the lower and middle class patients. On the other hand, in middle class areas this difference is much less marked, lower status patients apparently modelling their behaviour on that of their middle class neighbours. However, urban structure may be exerting an influence here. Middle class areas tend to be suburban and thus relatively far from most physicians.

The subsequent study by Shannon and Spurlock concentrated on the behaviour exhibited by respondents from the lower class area. However, the objective there was the introduction and illustration of a new concept rather than the refinement of existing ideas through empirical testing. They argued that the dynamic operation of urban systems influences the exposure to risk from communicable diseases

and environmental health hazards of population sub-groups. May (1950) is quoted as saying that '... disease ... occurs only if various factors coincide in time and space'. Thus Shannon and Spurlock introduce the idea of the Environmental Risk Cell as an area where health hazards are to be found. And they point out that it is not only residents of that cell who are at risk, but also people who move into it during the course of their daily activities. Unfortunately, having introduced the idea they do not focus their attention upon it, but use it simply as the backdrop to a study of the spatial relationship between daily activity patterns and the medical care facilities used by respondents.

The Standard Deviation Ellipse (a bi-variate version of the univariate standard deviation) was used to delimit the activity fields of respondents. Respondents were then aggregated into six groups on the basis of their daily activity patterns. Also, the areas where health care was obtained were delimited in the same way for the same six groups. It was then possible to compare the spatial extent of daily activity patterns with the spatial extent of health seeking behaviour. For most of the groups the 'activity' and 'health care' fields displayed considerable overlap and similar orientations - towards the city centre where most work and health care opportunities are situated. Two of the groups, however, showed relatively little overlap.

It appears that the overall point of this paper is that health care facilities used by particular groups should be geared to meet the types of health hazards that these groups encounter in their daily

activity fields. This is a very interesting and novel idea from the point of view of the geography of medical care, and it follows the spirit of the recommendations for further research made by Shannon, et al., in 1969. But before the true worth of the idea can be determined it is necessary to establish a link between Environmental Risk Cells and the types of disease that a given group experience. Also, hospitals will tend to offer most of the treatments required by their patients anyway - though this is a response to the types of illness actually presented rather than anticipation of the types that could be presented.

Such factors as those identified in the Chicago and Cleveland studies are likely to be much less important in the United Kingdom, where medical care is available to all under the National Health Service (NHS). Of course there will be other factors influencing the spatial behaviour of patients in the UK. Phillips (1978, 1979) has identified some of these factors. He examined the utilisation of, and attitudes to, GP services in West Glamorgan. Four pairs of enumeration districts were carefully selected and about one third of households in each EDs were approached for interview. In each of three of the pairs the EDs were adjacent to each other but of contrasting social composition. The purpose of this being to compare the behaviour of people from high and low status areas with similar access to the same set of GP services in three different parts of the study area. The fourth pair of EDs were of similar composition but had differing access to the same set of facilities. Thus the effect of accessibility on behaviour could be considered. Like Weiss and Greenlick before him, Phillips found that people of lower social

status were more likely to use the most accessible facility irrespective of whether it was a main surgery (or health centre) or a branch surgery. Higher status respondents, however, were more likely to attend the main surgery (or health centre). From a comparison of the two low status EDs with dissimilar access to the same set of facilities, Phillips concluded that patients living near a health facility were more likely to use it than people living further away. However, from the study as a whole he saw that low status patients who went beyond their nearest facility often tended to travel right into Swansea town centre for their primary medical care. Such behaviour was facilitated by the existence of good bus services into the town centre.

In addition to these general observations Phillips also considered the effect of personal mobility, age and previous area of residence on the pattern of utilisation. Personal mobility (if defined as the use of a car) is not necessarily associated with car ownership by the household because sixty per cent of adults in car owning households cannot drive and many more do not have access to the car during the day. Thus car ownership may not be the best indicator of personal mobility. Nevertheless, car ownership was associated with trips to surgeries beyond the nearest two. Car ownership, of course, was associated with high social status. However, as noted above, the availability of bus transport did allow low status respondents to travel relatively long distances. Despite this, whilst walking was the most common mode of transport for both low and high status groups, it was relatively most common amongst the low status respondents, reflecting a lower level of car ownership.

It was hypothesised that the age of patients would influence their spatial behaviour with regard to obtaining primary medical care. Very young children and the elderly, it was thought, would attend nearby surgeries whilst young and middle aged adults would be more likely to attend more distant surgeries. Despite the history of these ideas in the literature (e.g. Sumner, 1974) the evidence of his survey led Phillips to conclude that the spatial behaviour of patients showed no significant differences between age-groups.

On the other hand, a patient's 'previous area of residence' was found to be a '... highly significant variable in explaining spatial patterns of utilisation behaviour.' This variable corresponds to the preceding notion of patient loyalty mentioned by Morrill et al above. Like the work of Weiss and Greenlick with regard to distance, Phillips found that the effect of previous area of residence was class related. Low status respondents were most likely to be influenced by it because their change of residence tended to be intra-urban, whereas high status respondents were more likely to be inter-urban movers, and consequently not affected by their previous home location when selecting their doctor. The result is that high status respondents appear to behave more rationally in terms of the nearest centre hypothesis. That is, they attend their nearest surgery. Thus of the three factors which Phillips considered, age was found to be not significant whilst place of previous residence and personal mobility did contribute to the explanation of spatial behaviour, though these were both related to social class.

## Conclusions

This review has shown that distance may be considered as an independent or dependent variable. As an independent variable its effect was most clearly demonstrated on choice of facility (people tended to choose the nearest facility, particularly when emergency care was sought). Some evidence was also presented showing that distance can influence "illness behaviour". Little evidence was found to support the notion that demand for medical care is elastic with regard to distance.

Much interesting work has been conducted on the use of distance as a dependent variable. The general approach adopted was to examine differences in the distances travelled by different groups of patients. Social status, religion, race, patient loyalty, mobility, income and capacity of facilities were all identified as factors influencing the distances travelled by patients. Variations in behaviour were also apparent between people seeking different types of services.

For this study it is clearly important to establish the pattern of distances travelled by dental patients in Edinburgh. This will also indicate the influence that distance exerts on choice of dentist. Given this pattern, the objective is then to discover why patients do not always do the 'obviously sensible' thing and attend their nearest dentist. This review of literature suggests a number of factors to consider in this context. The capacity of surgeries, and the mobility and loyalty of patients are worth examining here. Surgery capacity, if insufficient to meet demand could cause patients to travel longer

distances than they otherwise might. If distance is seen as a barrier then patients with good mobility, e.g. car ownership, will be more able to overcome the 'friction of distance' than those without. They will thus find it easier to travel longer distances. 'Better the devil you know' may not be a flattering reason for patients continuing to attend the same dentist over a long period of time. Whatever the reason for patient loyalty, if the patient moves away from his dentist yet continues to attend the latter's surgery then this will certainly result in travelling longer distances.

An additional topic examined, (and one that does not appear to have been studied in terms of the use of medical care facilities) is the effect that the origin and destination of a trip to the dentist may have on the distances actually travelled. Thus the specific factors to be examined in this study in relation to the spatial behaviour of dental patients are: distance travelled, mobility, origins and destinations, patient loyalty and surgery capacity, the first of which will be treated as the dependent variable for the remaining four.

## Chapter Three

### Data Collection



The previous chapter concluded by discussing the areas of interest to be examined by this study. This chapter considers the collection of data necessary for that purpose. Clearly, the range of data to be collected is determined by the stated objectives. For this study data relating to both the supply of, and demand for, dental care are required. Four data sources have been used:

- 1) the 'Dental List' published by the Lothian Health Board. This was used to provide information on the distribution of surgeries and the number of dentists practising in them.
- 2) returns made by dentists to the Scottish Dental Estimates Board (SDEB) served two purposes. First, they indicated the number of patients treated at each surgery. And, secondly, they provided comprehensive coverage of the geographic behaviour of dental patients.
- 3) a questionnaire survey of dental patients at a sample of surgeries provided the more detailed socio-economic and personal information that the SDEB source did not. This was essential if detailed aspects of behaviour, and differences in behaviour between groups, were to be considered.
- 4) the 1971 census provided background information, to place the observed behaviour in its social and quantitative setting.

The following sections describe 'what' and 'how' information was abstracted from each of these sources. Some of the sections are also concerned with details of the initial processing of the data and with a consideration of the effect of non-response on the quality of the questionnaire data.

All the data were collected in such a way that would be suitable for computer processing. This constraint influenced the way that the data were collected. For example, as far as possible all data were collected in numeric form on prepared sheets. This minimised the need for transcription and facilitated the entry of data into the computer by the 'data prep' section of the university, in one step. In this respect the questionnaire is of note because it had numbers in the margin to indicate at what position on each card the data were to be 'punched'.

#### The Dental List

The Dental List for the City of Edinburgh and the counties of East, West and Midlothian, published by the Primary Care Division of the Lothian Health Board, contains the following information for each dentist practising in Edinburgh:

- 1) registration number;
- 2) name;
- 3) surgery address;
- 4) the time that he practices.

This information is assumed to be accurate for two reasons. First, the Dental List for any health board region is a list of all dentists practicing under the NHS. To receive payment for the work carried out under the NHS a dentist must be registered with the health authority in the area in which he practices. The health authority is the source of payment; without registering the dentist cannot be paid. Thus all dentists offering dental care under the NHS will be known to the local health authority.

Second, the Dental List is updated every three months. Details of new dentists to the area, and a list of dentists who no longer practice in the area, are contained in the update. The edition of the Dental List used for this study was published in 1975, and was supplied with the updates to 1st April, 1977 - the start of the active period of this research. This provided the addresses of 106 NHS dental surgeries in Edinburgh. These were plotted on a map and the grid references recorded.

Details of the hours that a dentist worked - item 4 above - were not always precise. Some entries simply stated 'by appointment'. Consequently, this source could not provide accurate information on surgery capacities.

#### The Scottish Dental Estimates Board

The SDEB is the NHS agency that administers the payment of General Dental Practitioners in Scotland. They do not themselves pay dentists; that is the duty of the local health authorities. Rather, they act as the link between the dentist and his local health authority by checking that appropriate treatment has been administered by the dentist and by authorising local health authority to make payment for it.

In order to illustrate the relevance of the SDEB as a source of information, its administrative function is described in the following sections.

## SDEB Administrative Function

All dentists in Scotland practicing under the NHS must return a copy of form E.C. 17 to the SDEB for each course of treatment they administer, otherwise they cannot be paid. The SDEB, therefore, is the administrative centre of dental care in Scotland.

A course of treatment comprises the treatment required to bring a patient to a state of 'dental fitness'. That is, to a condition where he is enabled to make the best possible use of his teeth. Treatment may be administered over a number of attendances, depending on the amount of treatment required. When this course of treatment is complete, form E.C.17 must be completed by both dentist and patient.

Form E.C.17 itself provides the data that enables the SDEB to perform its function. It contains three types of information, relating to the patient, the dentist and the treatment. For the patient general details such as name, date of birth, and address are recorded. From the point of view of the SDEB it is important to have a record of the patient's address. It is possible that dental inspectors from the SDEB may want to check the work of a particular dentist. To do so, patients have to be examined after the course of treatment has been completed. It is a condition of NHS treatment that dental patients allow themselves to be examined, if required, by such inspectors. In order to contact patients in these circumstances the SDEB must have a record of where the patient lives.

Personal information concerning the circumstances of the patient is also recorded. These details are solely to help the SDEB determine

whether the patient is receiving any kind of benefit from the welfare services. If so the patient may receive his treatment free, or at a reduced rate, and the appropriate welfare service is charged the fee.

It is important to identify the dentist who administered the treatment and the location at which this was performed. This information would provide a measure of surgery capacity as well as the geographic coordinates of the surgery attended by each patient. On Form E.C.17 the dentist supplies his name, surgery address, and registration number. Of these, the latter is most important for administrative purposes. Local health authorities issue their payments to the dentist identified by the registration number, and not necessarily to the dentist whose name and address appears on the form. The reason for this is that some surgeries have more than one dentist. In such circumstances some surgeries may be identified by a stamp showing the name and address of the principal dentist. It is thus necessary to clearly identify the dentist to be paid by means of his registration number.

Details concerning treatment fall into two categories. The first deals with the type of treatment administered, and includes an assessment of the patient's dental status at his initial examination. Each item of treatment administered has a nationally agreed fee that the dentist claims. These claims comprise the second category.

It is the information concerning the treatment that most concerns the SDEB. This is checked and, if it appears reasonable, the relevant local health authority is authorised to make the payment claimed by

the dentist. However, authorisations are not issued willy-nilly. The SDEB work to a monthly time scale. All E.C.17 forms received up to the 27th of each month are processed together. Authorisations to make payment are issued once monthly.

This, then, is the context within which the SDEB functions. As such it appears an ideal source of data concerning the spatial distribution of patients, their choice of dentist, the distribution of surgeries, and the number of patients attending each surgery. The next section describes the practical details of how data were obtained from this source.

#### Data Collection from SDEB

Permission was obtained from the SDEB to use this information. However, the E.C.17 forms received by the SDEB are stored alphabetically, by the surname of the patient. No geographic classification is made. With the returns of all patients in Scotland filed alphabetically it would be virtually impossible to identify a satisfactory sample of patients treated by dentist in Edinburgh.

Fortunately, it was possible to establish a more direct means of identifying the appropriate returns. All returns are sent by post, or handed in personally, and are initially processed in the 'post room' of the SDEB. At that point it is possible to identify returns by dentists from Edinburgh simply by the postmark on the envelope. Failing this, the contents of the envelopes would speak for themselves! This proved to be a very efficient way of selecting the appropriate forms because, instead of arriving singly, they

invariably arrive in 'bundles' i.e. several per envelope.

Occasionally, they are quite large bundles. It was agreed with the SDEB that, with the assistance of the 'post room' staff, the dental returns would be sampled at this point in processing.

Given that returns for all patients treated by all dentists practicing under the NHS are sent to the SDEB, a sampling strategy was developed. The sample would automatically be spatially representative of both supply and demand if forms from all dentists were selected. As stated earlier, authorisation to pay a dentist can be issued by the SDEB for only those returns received during a particular month. However, returns may be sent to the SDEB as frequently during the month as the dentist wishes. Thus dentists may send their returns daily, weekly, only once during the month, or whenever they may choose. Hence, in order to ensure that all dentists are sampled, the sampling process had to be operated for a full administrative month.

During an administrative month the SDEB receives approximately 20,000 returns from dentists practicing within Edinburgh. Such a number was considered too large to be processed by one person during the available time. Consequently, the sampling problem resolved itself to one of reducing the number of returns selected from each 'bundle'. It was considered that as large a sample as possible should be obtained. Approximately 5,000 was assumed to be the upper limit of manageability. Consequently, one in every four returns in each bundle was sampled.

This sampling strategy was implemented during the administrative month of September, 1977. It resulted in a sample of 5,192 returns. From each of these the following information was collected:

a) for the patient-

- 1) age;
- 2) sex;
- 3) address;
- 4) dental status on initial examination;
- 5) treatment received.

b) for the dentist-

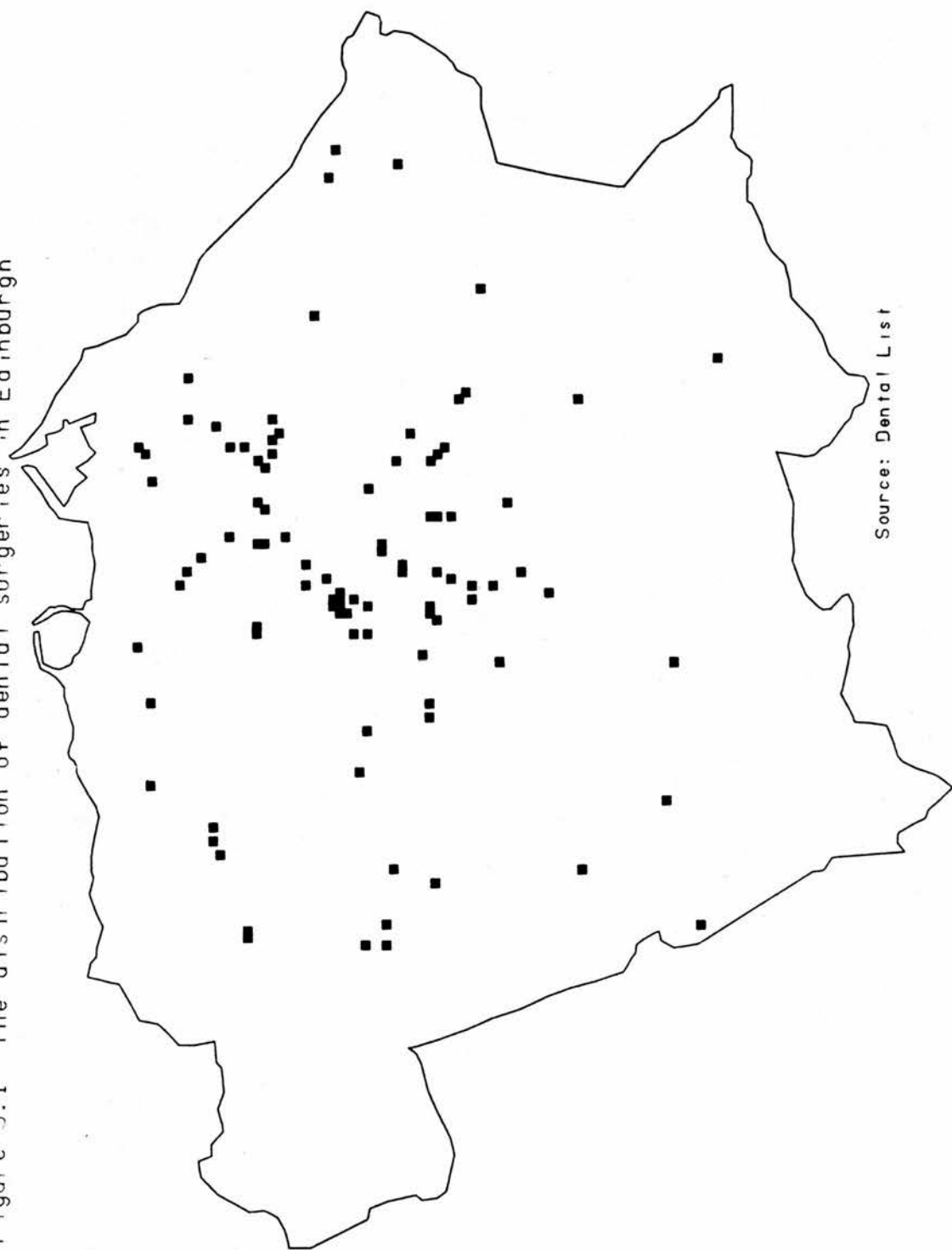
- 1) surgery address;
- 2) registration number.

The information revealed that 779 of the returns were for patients living outside Edinburgh and were thus outwith the scope of the study. Hence the sample was reduced to 4413 returns. Nevertheless, from the procedure outlined above, this sample was known to be representative of returns made during September, 1977. There is no reason to suspect that there would be any spatial bias in the distribution of patients attending a dentist during that month.

From the Dental List 106 surgeries had been identified. However, no returns were received for ten of these. Because of this the total number of surgeries providing NHS care was reduced to 96 (Figure 3.1). The information showed also that there were fifteen dentists practicing during this month who had not been listed in the Dental List (as updated to 1st April 1977), though they had been practicing in surgeries in the Dental List.



Figure 3.1 The distribution of dental surgeries in Edinburgh



Source: Dental List

Because of the spatially representative nature of the sample, the SDEB data provide accurate information on:

- a) the number and location of surgeries;
- b) the number and distribution of patients;
- c) the number of patients attending each surgery.

This latter point amounts to a measure of the capacity of surgeries to offer treatment under the NHS, using the number of completed treatments as the unit of measurement.

Unfortunately, however, the SDEB source does not offer socio-economic information nor finer details of the spatial behaviour of dental patients. That is, it does not provide the background information in which to set the observed behaviour. Consequently, an alternative source was used for this, a questionnaire survey of dental patients themselves.

### The Questionnaire Survey

A study of the spatial behaviour of dental patients requires consideration of the nature of the journey to the dentist. Only the patient can provide this information. The purpose of this section is to describe the problem encountered in implementing a questionnaire survey of dental patients, and to describe the solutions adopted.

### Questionnaire Type

The primary requirement of any survey is that the information collected be as accurate as possible. A secondary requirement is that the nature of the survey should be as conducive as possible to

its success. Both these points were considered when making the choice of questionnaire type.

A visit to the dentist is just one of many activities that may be engaged in by a dental patient during a day. Such visits are relatively infrequent. Excluding emergencies, dental treatment under the NHS cannot normally be obtained less than six months after the preceding course of treatment has been completed. It is quite probable that the details of any particular attendance are quickly forgotten.

Neither a home interview nor a postal questionnaire survey were considered appropriate for this study. Neither method would, with any certainty, select people who had attended their dentist very recently. Also, the dependence on memory would affect the accuracy of responses. Accordingly, the information was collected from a survey conducted at the surgeries. Here, the details of the journey to the dentist would be fresh in the minds of patients. Accordingly, there are two ways of conducting surgery surveys: the surgery interview or the self-administered questionnaire. Both have implications for this study.

### The Survey Interview

The major advantage of the surgery interview is that the details of the patient's spatial behaviour are unlikely to have been forgotten, therefore responses should be accurate. In addition, it is possible to ensure that the patient understands the question being asked.

Unfortunately, there are two significant disadvantages in using this method. First, it requires the physical presence of an interviewer

in the surgery. Most surgeries are extremely busy and an interviewer stationed in the surgery would inevitably be 'in the way'. To many dentists especially those in small premises, this would be unacceptable.

Secondly, there is the fact that the interviews, even those with relatively few questions, are time consuming. This is important for two reasons. Surgeries run to a tight schedule, and any interruption to that schedule would be a major inconvenience, perhaps to an unacceptable level. Also, the patient himself may be inconvenienced by the time taken for the interview, especially if, to avoid the previous point, interviews were carried out after the patient had seen the dentist.

A possible variation on the surgery interview method would be to interview patients outside the surgery. The benefit of this approach is that it is not necessary to obtain permission from the dentist to conduct the survey. However, a number of points should be noted. The first is that patients could only be interviewed as they were leaving the surgery. To do so when entering the surgery would conflict with the patient's appointment time. It is likely, though, that interviews on leaving would also cause conflict. For example many patients will have had treatment prior to leaving the surgery and may not be willing to answer questions in a verbal manner. Also, many patients may resent the inconvenience caused by the time requirements of an interview, especially as, once having left the surgery, most patients would be intent on reaching their next destination. Such a consideration would be compounded by inclement

weather. Thus many patients, for one reason or another, might be unwilling to respond to such a survey.

#### Self Administered Survey at the Surgery

The self-administered questionnaire has several attractions. First, it is unobtrusive and therefore the dentist is more likely to permit the survey into his surgery. Second, and perhaps most important, is that it collects information that is still fresh in the respondents' memory.

From the patient's point of view the self-administered questionnaire is faster to complete than an equivalent interview; in many surgeries there is time before the patient sees his dentist to complete the questionnaire. Even if there is not, he can start it and thus not be faced with the whole questionnaire to finish after his appointment.

Unfortunately, this approach suffers, to an extent, from the same problems as the postal questionnaire. First, there is no guarantee that all patients will understand all the questions. And second, there is no way of ensuring a satisfactory response rate. However, it is possible to design and test questionnaires so that they 'work' in most circumstances. Also, because it was intended that the questionnaires would be distributed by surgery receptionists, this would convey to the patient the impression that the survey was 'official', and would thus secure a higher response rate than otherwise. Of course this method of administering the survey is dependent on the willingness of receptionists to distribute the

questionnaires.

The discussion of possible questionnaire methodologies has pointed to the fact that the method chosen should be surgery based, in order to avoid inaccuracies from memory dependent responses. For this reason, and because it would be the most acceptable to both dentists and patients, it is considered that the self-administered survey is the most appropriate method to use.

### Questionnaire Design

The greatest constraint upon the questionnaire was the criterion that it should be capable of completion in an acceptably short period of time, about six to eight minutes. This criterion was decided on to encourage dentists to allow the survey into their surgeries and to avoid inconveniencing respondents. Clearly this limits the number and depth of possible questions. Because of this constraint it was decided that responses to most questions should be factual, to ensure that the majority of answers were already known to the respondent and thus require little reflection.

An initial list of general topics for the questionnaire was drawn up, as follows:

- 1) personal details - age, sex, address and occupation;
- 2) position of the attendance amidst other daily activities;
- 3) mode of travel;
- 4) long term attendance pattern;
- 5) dental status.

To this was later added:

- 6) spatial awareness;
- 7) motivation to attend a dentist.

The choice of these question topics was plainly dictated by the objectives of the study. On the basis of previous studies and the broad hypotheses outlined earlier at the end of Chapter Two it was considered that these types of variables would most suit the investigations to be undertaken regarding the spatial pattern of use of dental care, and help to account for it. Additional themes - prestige of the dentist and fear of pain - were rejected because dentists themselves might have objected to them.

When developing a questionnaire it is almost inevitable that one will not 'get it right' first time. A questionnaire is not right or wrong, it either works or it does not. Therefore, 'getting it right' is an iterative process in which several forms of the questionnaire are tested. The development of this questionnaire was aided by discussion with friends and colleagues and by the results of five one-day pilot surveys, using open ended questions.

Efforts were made to lay it out neatly so that it would have a clear structure. It was hoped that this would be a positive aid to respondents understanding and completing the questionnaire. Also the questions were phrased as simply and unambiguously as possible. And many of the questions in the final form of the questionnaire (appendix 3.1) are followed by a list of alternative answers, requiring the respondent only to ring the appropriate number. Secondly, it tested whether the number of questions was too many for respondents to cope with and whether the questionnaire 'worked' in

both 'middle' and 'working' class areas.

Finally, the pilot stage allowed an initial evaluation of the willingness of dentists to permit the survey into their surgeries. Six were approached for pilot surveys, of whom only one refused. This indicated that, overall, dentists would generally be quite receptive to the survey.

### The Sample

Decisions concerning the sampling rationale proved extremely difficult to take. This was firstly because the variability in the population being sampled (dental patients) was unknown. Therefore, problems such as sample size could not be resolved using standard sampling methods, and a more pragmatic approach had to be adopted. And, secondly, because in order to sample patients it was first necessary to sample surgeries.

For this study it is the location of surgeries that is their most important feature. Consequently, the two alternative strategies considered for sampling surgeries were based on location. The first method would have involved placing a one-kilometre grid over Edinburgh and sampling one surgery from each cell in which surgeries are found. This approach would have ensured that surgeries from all parts of the city were represented in the sample. However, the sample size that would result from this method was forty-two, too large to handle within the time and cost constraints of this study. Therefore this approach was rejected.





The second method involved an areal stratification of the city (to form a spatial framework for the sample). Stratification involved a two-fold division of Edinburgh, firstly, into 'high' and 'low' social status areas - based on a study by Cargill (1975). And secondly, into central and peripheral areas - based on the 'dense built-up' areas of the 'Edinburgh City Plan', published by Bartholemews. This gave a 2 x 2 typology (Figure 3.2). When mapped, the typology results in ten separate areas (Figure 3.3).

The assumptions behind this approach include the notion that surgeries in 'middle class' areas may attract patients who, as a whole, are recognisably different from those that attend surgeries in 'working class' areas. For example, the mode of travel, journey time, and distance travelled could all be different. And, surgeries in the central part of the city may draw their clientele from more widespread parts of the city than do the suburban surgeries. In addition, a large proportion of their patients could be expected to attend from work, as compared to suburban surgeries.

Given that surgeries have been stratified according to a spatial framework, it then remains to select a sample of manageable proportions from within it. A sample size in the mid-twenties was considered within the capabilities of this study. There are 96 surgeries in Edinburgh. Consequently, a sampling fraction of 1:4 was adopted, with the proviso that areas with less than four surgeries would have one surgery selected. All selection would be on a random basis within each area. Use of this sampling fraction yielded a sample of twenty-seven surgeries.

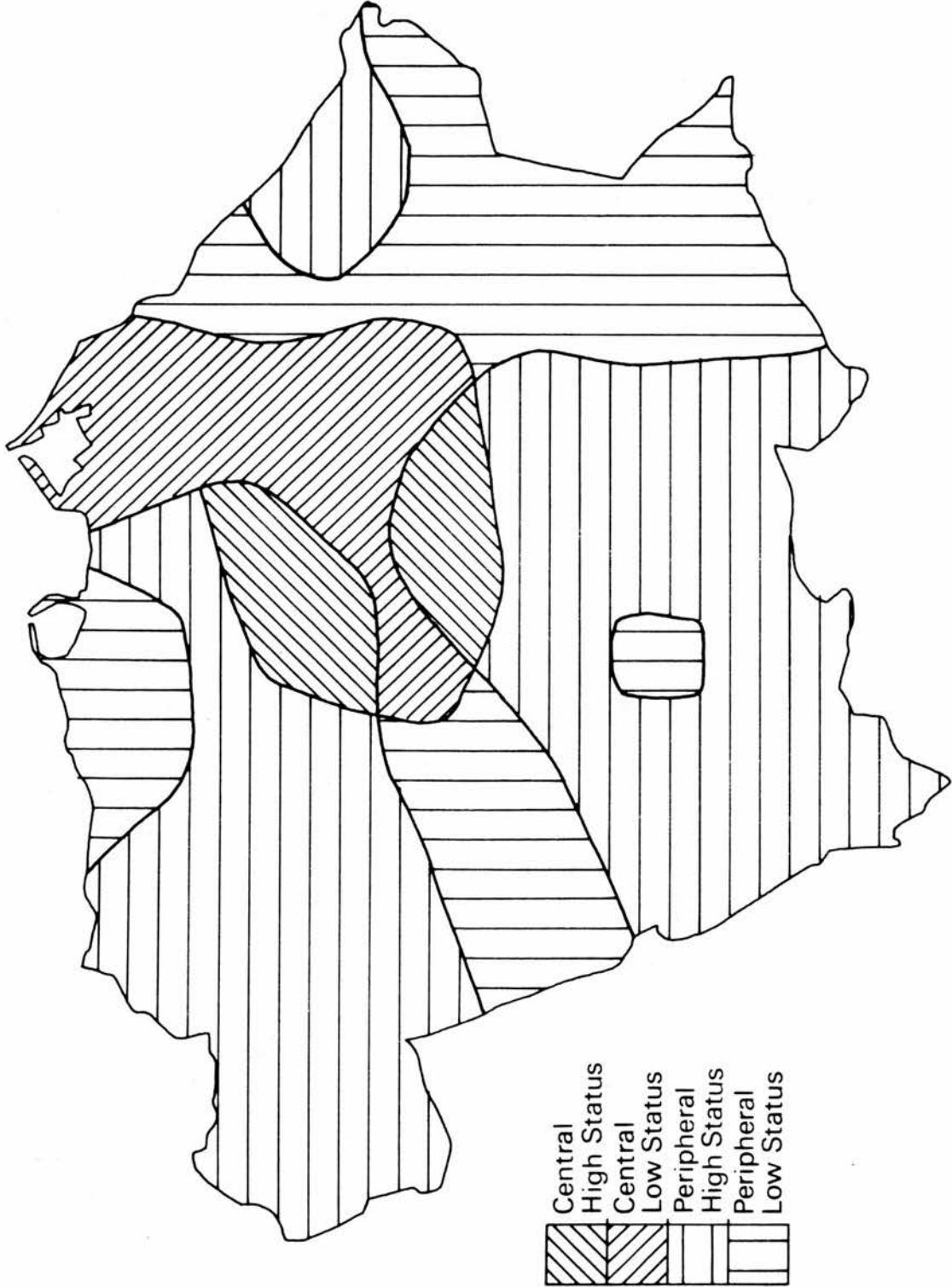
Figure 3.2 Sampling typology

LOCATION		STATUS
Central	Peripheral	
High Status	High Status	
Low Status	Low Status	

Sources : Cargill, 1975

Edinburgh City Plan, Bartholemews

Figure 3.3 Spatial framework for the questionnaire sample



Given the strategy for sampling surgeries, there still remained the problem of sampling patients at each surgery. As the variability of patients is unknown any choice of sample size would be largely arbitrary. The only guide was that different dentists had different hours of opening during the week. For example, some worked standard office hours - 9am to 5pm, with or without a lunch break. Others started at 8 am, took lunch from 12 noon - 2 pm, and closed at 6pm. Further, some worked on Saturday mornings whilst others did not, and some took one or more mornings or afternoons off per week. Thus there was considerable intra-week variation in time worked by dentists. It is quite possible that different types of people will attend at different times of the day and week. To ensure that the sample of patients was representative of all patients attending each surgery it was therefore decided that the sample should be of all patients attending the selected surgeries during the dentists' 'working week'.

Thus the first stage of the sampling strategy adopted here is a stratified sample of surgeries, and the second is a constant proportion sample of patients attending each selected surgery, in the sense that that one week is roughly one 52nd of the surgery's annual workload. As such this strategy represents a pragmatic solution to a particular sampling problem which, because of the exploratory nature of the study, could not be solved by reference to preceding work in the field.

## Survey Implementation

### Surgeries

Once surgeries were selected a letter was sent to the respective dentists explaining:

- 1) the requirement to conduct a questionnaire at each selected surgery;
- 2) the proposed method of administering the survey;
- 3) the implications of this for the surgery;

(A copy of the letter is shown in appendix 3.2.).

A total of forty-eight dentists were approached before the sample of twenty-seven surgeries was completed. In other words, twenty-one refused to allow the survey into their surgeries. The positive response rate for dentists was thus 56 per cent. This is rather different from the expectation following the pilot surveys, where a positive response rate of 83 per cent was obtained.

Whenever permission was refused a replacement surgery was chosen, on a random basis, from those remaining in the same area. The sample resulting at the end of this process of substitution was, thus, to some degree, self-selected. Clearly, this is at variance with the initial process of random selection and could mean that surgeries included in the survey are not representative of surgeries generally.

However, there was no alternative to this procedure. If the initial sample had been held to, without replacement, the final sample could not have been equally representative of each area. To achieve this the required number of surgeries had to be met. The problem is that

those dentists that refused and those that did not may be two separate sub-groups within the population, of which neither is completely representative.

### Patients

Despite every effort to ensure that all patients at each surgery were asked to complete a questionnaire, the response rate was variable, ranging from as low as twelve per cent to as high as one-hundred per cent. As such there is a chance that results from surgeries with low response rates would be relatively unrepresentative of those surgery's clientele. From discussion with dentists and staff at each surgery following the survey, it became apparent that low response rates reflect the extent that patients were asked to complete questionnaires, rather than their willingness to do so. In some surgeries this was the result of staff being too busy to ask every patient, in others it represents a general unwillingness, for whatever reason, to ask patients. There were, of course, patients who were unwilling to complete a questionnaire, but the generally high response rates of most surgeries would suggest that these were relatively few in number.

A low response was defined, quite arbitrarily, as one less than sixty per cent. There were seven such surgeries, with response rates ranging from twelve to forty three per cent.

Nevertheless, as with negative responses from dentists, the fact of a low response from a particular surgery does not necessarily mean that response is unrepresentative. Questionnaire responses were checked

for representativeness by comparing the responses for each surgery with the SDEB data for the corresponding surgeries. Comparability between the SDEB and questionnaire data sets is limited to: age, sex, and distance-to-surgery. If these variables show similar distributions in both data sets this will be taken as an indication that non-responders to the questionnaire survey are no different from responders. It is assumed that the SDEB data, because of their comprehensive nature, are representative of the patients attending each surgery. Details of this comparison are presented in the final section of this chapter.

#### The 1971 Census

To set this study in context a knowledge of the spatial distribution of the population of Edinburgh and its socio-economic characteristics was required. This information would serve as the background to the study, and allow some estimation of the relationship between the general population and dental patients. The best and most recently collected data are those contained in the 1971 census. Whilst not completely up to date it is unlikely that these data will be very inaccurate. There may have been some shifting of the population from one part of the city to another but this is not likely to have been very extensive. In any case, though individuals may move, the overall characteristics of an area will tend to change only slowly, unless an area is totally cleared or a new residential area is built. Though both of these have certainly occurred in Edinburgh between the 1971 census and the survey period, the overall socio-spatial structure of the population is unlikely to have changed radically during this period.

The enumeration district is the smallest spatial unit covered by census data. It was chosen as the basic unit for this study because it offered most flexibility for future aggregations. In an urban area there are usually about one-hundred and fifty households in an enumeration district and in 1971 there were 1346 enumeration districts in Edinburgh.

Small Area Statistics from the 1971 census were available for Edinburgh on magnetic tapes held by the University of Edinburgh Library. These were accessed by means of a number of small programs issued by the Program Library Unit (Kirby, 1977). The following items were extracted from each enumeration district in Edinburgh:

- 1) grid reference;
- 2) total population;
- 3) the number of males and females;
- 4) the number of households with one car and with two or more;
- 5) the proportion in each of seventeen socio-economic groups;
- 6) the number in each age-group;
- 7) the number of households in each of four types of accommodation:
  - i) privately owned;
  - ii) council accommodation;
  - iii) rented/unfurnished;
  - iv) rented/furnished;
- 8) the number of people with one of three levels of education:
  - i) basic qualifications - up to O' level;
  - ii) intermediate qualifications - up to A' level;
  - iii) higher qualifications - degree plus.



### Initial Processing

Before the data could be analysed they had to be subjected to some pre-processing. The purpose of this was to establish, on computer, the locational information contained in patients' addresses, to create links between the data sets, to allow comparisons, and to reduce unnecessary complexity in the data.

### Addresses

The most important aspect of this pre-processing concerned the home location of dental patients. In both the SDEB sample and the questionnaire survey, patients' addresses had been collected in long hand form. Questionnaire respondents had also been asked for the address at which their journey to the dentist had originated, as well as that of their destination upon leaving the surgery. Before these data could be entered into the computer the addresses had to be changed into numeric form. One method of achieving this would be to identify on a map the location of each address and simply record the grid reference. However, though this method would be accurate it would not allow the SDEB and questionnaire data to be related directly to the census. To achieve this it was necessary to identify the 'home' enumeration district of each patient.

It was known that the General Register Office (GRO) in Scotland was preparing the 1981 census, in which the basic spatial unit was to be the postcode. In preparing for this they had produced lists showing, for each postcode, the enumeration district (from the 1971 census) <sup>ie</sup> which contained that postcode. A list was obtained from the GRO for this study.

The postcode of most addresses can be identified from the book of 'Postcodes, Edinburgh and District' (1975). The Post Office also kindly accepted my request to check those addresses for which I could not find a postcode, these mostly being for post 1975 addresses. In this way all addresses in Edinburgh were allocated a postcode.

Once all the postcodes had been identified the code number of the corresponding enumeration district was allocated to each SDEB and questionnaire response. This was a straightforward matter in most cases but in the case of some new residential areas postcodes could not automatically be allocated to an enumeration district. The problem was solved by creating thirteen 'new' enumeration districts for the purposes of this study. Respondents allocated to these newly defined areas, however, could not be used in any areal comparison with the census.

Once the code number of each respondent's home enumeration district had been recorded, the SDEB and questionnaire data sets could then be entered into the computer. The grid-reference of the enumeration district mid-point was then obtained from the census data set.

### Spatial Aggregation

The 1346 enumeration districts in Edinburgh are distributed in an apparently haphazard manner. To reduce the complexity of this pattern the enumeration districts were subjected to a process of spatial aggregation to produce a more regular framework of areal units. A half-kilometre square grid was superimposed upon Edinburgh and each enumeration district was allocated to that cell in the grid which

contained its mid-point. This produced a total of 347 cells (Figure 3.4). Of these 342 contained census enumeration districts. The thirteen extra areas identified for this study occurred in only five of the grid cells. The latter were suburban in nature, three comprising the new council housing estate at Wester Hailes, the other two being private housing developments.

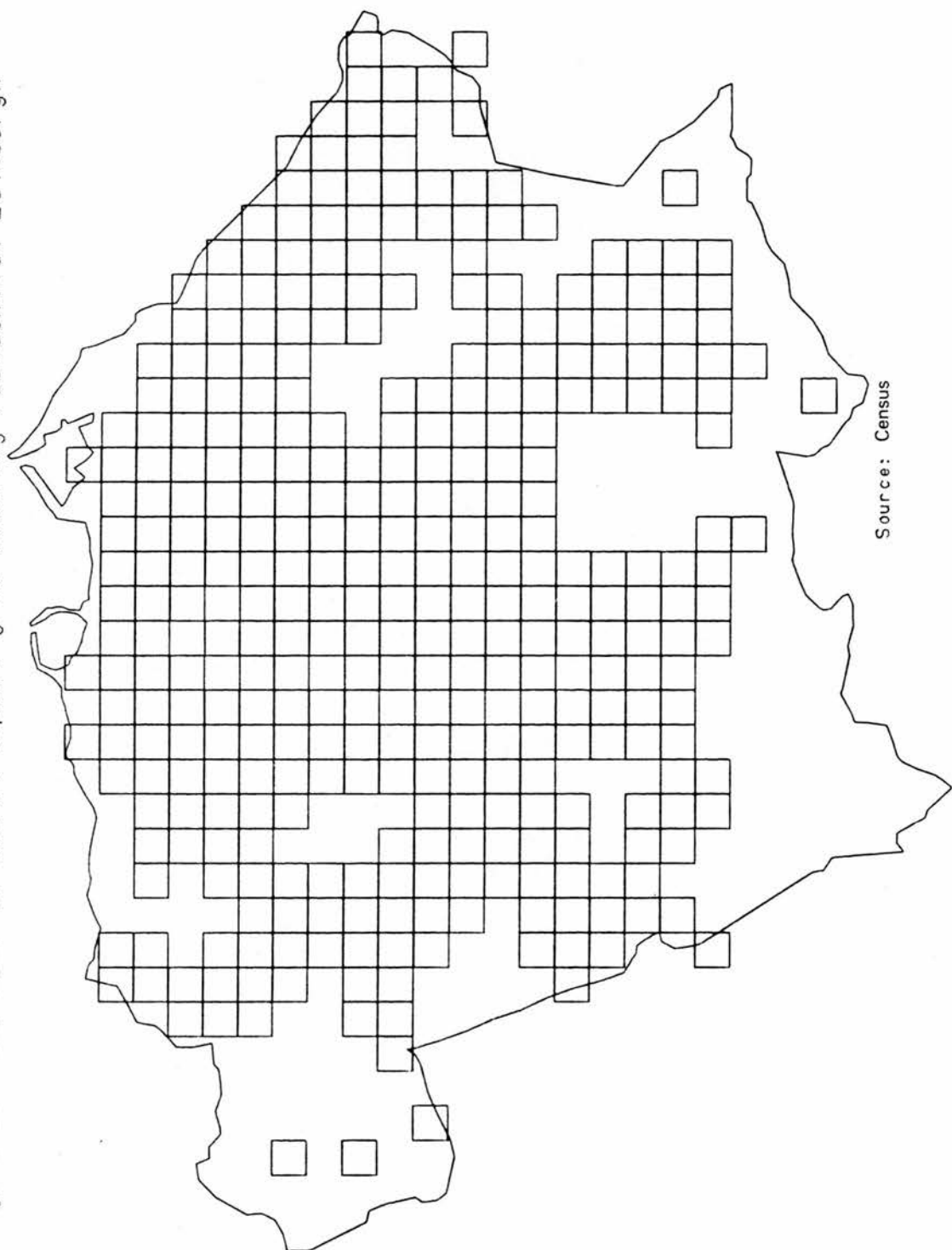
The advantage of this agglomeration is the reduction in complexity achieved by reducing the number of spatial units and by regularising the pattern. The 347 cells seem quite sufficient to retain most of the spatial diversity of respondents' home locations. In addition, the grid pattern produced is more amenable to mapping than is the more haphazard pattern of enumeration districts.

#### Age-groups

Age was available from the SDEB, questionnaire and census data sets, though in the latter case this was in the form of age-groups. To enable cross-referencing, the same class intervals for age-groups had to be used for all data sets. No existing rationale was available to guide the choice of age-groups for this study, therefore 'common sense' categories were used:

- 1) 0-4 pre-school children;
- 2) 5-10 primary school children;
- 3) 11-15 secondary school children;
- 4) 16-20 late teenage;
- 5) 21-34 young married people;
- 6) 35-44 early middle-aged;
- 7) 45-54 middle-aged;

Figure 3.4 The half-kilometre square grid covering residential Edinburgh



- 8) 55-64 late middle-aged;
- 9) 65+ elderly.

Each SDEB and questionnaire respondent was allocated to the appropriate age-group. For the census data, the number of people in each age-group in each enumeration district was calculated. When necessary, all three data sets could be aggregated to the half-kilometre square level.

### Social Status

Socio-economic status concerned only the questionnaire and census data. The census categorises individuals into one of seventeen socio-economic groups (SEGs), according to the occupation of the head of the household. Questionnaire respondents were asked for their occupation, or for that of their husband or father where appropriate. The information was then used to identify the appropriate SEG from the Classification of Occupations (1970).

Thus the questionnaire and census use the same units with regard to socio-economic status. However, seventeen SEGs appeared an unnecessarily large number. Consequently, they were aggregated into four categories, following the work of Robson (1969). Throughout the remainder of this study they will be referred to as socio-economic categories (SECs). They may be characterised as follows:

- 1) professional;
- 2) intermediate/non-manual;
- 3) foremen/skilled/self-employed;
- 4) unskilled;

It was not always possible to clearly identify an SEC for questionnaire respondents. In such cases (where there was a response but the occupation could not be identified) they were allocated to a fifth category. However, this category has no counterpart in the census and cannot, therefore, be used in comparisons.

Finally, it should be noted that census information on the SEG distribution in the population was obtained from the ten per cent sample rather than the one-hundred per cent survey. Consequently, their accuracy, vis-a-vis a particular area or the census as a whole, must be viewed in the same light as all sample data - with caution.

#### Non-Response in the Questionnaire Survey

The purpose of this section is to consider the effect of non-response by dental patients on the representativeness of the results obtained by the questionnaire survey. This is achieved by comparing the questionnaire survey results with those obtained by the SDEB sample. Only three variables are available for this comparison: the age and sex distributions and home-surgery distance of patients. It is an assumption of this comparison that the information collected from the SDEB sample reflects the characteristics of each surgery's clientele more accurately because there were no non-respondents in this sample. Thus any differences between the SDEB and questionnaire data sets will be taken to indicate that non-response by dental patients has biased the results of the questionnaire survey.

Comparisons of the three variables will now be presented, together with a final assessment of the overall representativeness of the questionnaire survey data.

## Age

To test whether the age distributions in the two samples at each surgery were different the Kolmogorov-Sminov test was used. The K-S test is suitable for ordinal level variables that have the categories ordered from largest to smallest, or vice versa (Norcliffe, 1977, p.102). Consequently, it is suited to the present purposes, where the nine age-groups progress from youngest to oldest. When used with two samples the K-S test is based on the maximum difference between the respective cumulative distributions of the chosen variable, that is, the proportion of observations in each category (age-group) is calculated, and then progressively summed across all categories to give the cumulative proportional distribution. It is the maximum difference between the cumulative distributions of both samples which the K-S test uses. For given sample sizes and a chosen level of significance there is a maximum allowable difference. Should the observed difference be greater than this figure it would indicate that the two samples were not drawn from the same population, and thus that non-respondents to the questionnaire survey were different from respondents.

With the objective of identifying a difference, in no matter what direction, the test is two-tailed. When the chosen level of significance is 0.05, the maximum allowable difference is calculated by:

$$\frac{1.36}{\sqrt{\frac{N_1 + N_2}{N_1 \cdot N_2}}}$$

where  $N_1$  and  $N_2$  are the sizes of the respective samples.

The K-S test results revealed significant differences between the two samples at all surgeries (Table 3.1). Hence it must be assumed that the age distribution contained in the questionnaire sample is not representative of each surgery's clientele. That is, they are biased.

The figures for each surgery were examined in some detail to try and identify the nature of the bias. This can be illustrated by the aggregate distributions for both samples (Figure 3.5).

Unfortunately, the questionnaire failed to identify the proportion of patients in the younger age-groups that the SDEB sample did. It is considered that the reason for this lies in the method of data collection. Child dental patients, especially if unaccompanied or together with other children in family groups, would possibly tend to respond less readily than adult dental patients. This could be because of difficulties they may have in understanding the questionnaire or because the accompanying adult might object to completing one questionnaire per child. In anticipation of this, instructions were left with the surgery receptionists that when there was more than one child the accompanying adult be requested to complete one questionnaire for one child and add the age, sex and address of additional children in the margin. If the child(ren) was unaccompanied it was asked of the receptionist that she fill in the age, sex and address in the questionnaire on the child(ren)'s behalf.

In the majority of cases these instructions have been followed. However dental receptionists are busy people and it is likely that, in some circumstances, some children would slip through the net. The



Figure 3.5 Aggregate age group distribution for both samples

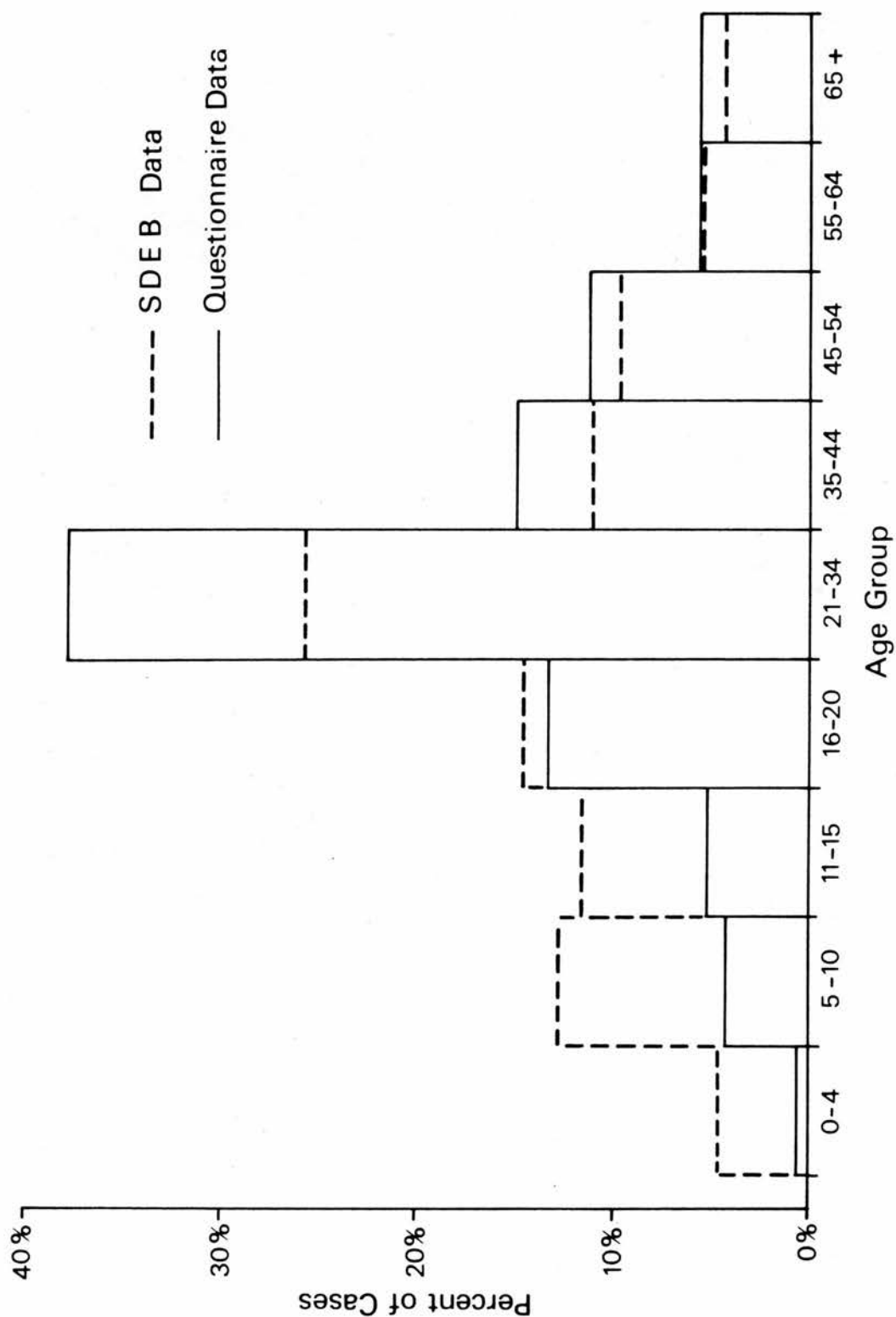


Table 3.1

Sample Differences - Age-groups

<u>Surgery</u>	<u>Quest.N</u>	<u>SDEB.N</u>	<u>Max.Diff.</u>	<u>Max.Allowed</u>
6	69	35	0.41	0.10
10	62	48	0.31	0.09
14	19	65	0.45	0.14
17	31	20	0.19	0.16
23	114	60	0.16	0.06
28	47	38	0.24	0.11
32	29	28	0.15	0.14
35	137	75	0.17	0.06
41	42	102	0.16	0.08
62	43	90	0.27	0.08
63	59	30	0.41	0.11
65	36	24	0.44	0.14
72	86	87	0.26	0.06
73	32	49	0.37	0.11
75	89	80	0.12	0.06
77	112	91	0.22	0.06
79	47	52	0.33	0.09
83	54	15	0.18	0.16
87	54	29	0.15	0.11
88	77	28	0.13	0.11
91	60	139	0.24	0.06
92	49	76	0.43	0.08
94	113	58	0.22	0.08
95	108	43	0.21	0.08
96	27	41	0.27	0.13
97	122	56	0.13	0.08
99	83	55	0.29	0.08

---

presence of this relative deficit in the younger age-group, measured in percentages, naturally means that the remaining categories are relatively larger than their SDEB counterparts. Thus the deficit of child respondents also produces the apparent excess in the older-age groups of the questionnaire data.

Whilst significant differences between the two samples were found at all surgeries, the aggregate level distributions (Figure 3.5) reveals a fundamental similarity. The same underlying distribution is common to both - small values at the extremes of the range, rising to a peak

in the 21-34 age-group.

### Sex

As the proportion of patients of one sex is the counter image of the proportion of the other, the comparison of the sex distribution at each surgery is based solely on the proportion of male patients. Identical conclusions would have been drawn if the proportion of females had been used. At each surgery the proportion of males in the two samples was compared by computing a 'z' statistic using the following formula:

$$z = \frac{P_1 - P_2}{\sqrt{pq \left( \frac{1}{N_1} + \frac{1}{N_2} \right)}}$$

where:

$P_1$  = the proportion of males in the SDEB sample;

$P_2$  = the proportion of males in the questionnaire sample;

$p$  = the proportion of males in the two samples combined;

$q = 1 - p$ ;

$N_1$  = the size of the SDEB sample;

$N_2$  = the size of the questionnaire sample.

The computed 'z' score is then compared with tables of the area under the normal curve to determine the level of significance. This is set against the chosen significance level of 0.05. Values, for a two-tailed test, equal to or smaller than this denote significant difference between the samples.

Using this test significant differences between the two samples were found at only two of the surgeries (Table 3.2). On the basis of this evidence it seems reasonable to assert that the questionnaire data is not biased with regard to the sex distribution of respondents.

#### Mean Distance to Surgery

Statistical difference between the two samples, at each surgery, of the mean distance between the patients' homes and surgeries was sought. An examination of Table 3.3 reveals that the variances for both samples, at each surgery, tend to be dissimilar. Consequently, it was assumed that the variances were not equal, and the appropriate model of the comparison of means test was used (Norcliffe, 1977, p. 152). In this test, for each pair of means a Student's t value is computed and compared with a tabulation value. If the calculated t value is greater than the tabulated, then the hypothesis of no difference should be rejected. The test requires that both samples be equal to, or greater than twenty-five cases.

Table 3.3 shows that at only two surgeries is the null hypothesis rejected. However, one of these surgeries (14) and three others (17, 65, 83) have sample sizes of less than twenty-five cases. The sample size requirement is thus not met at these surgeries and any conclusions drawn from the results of this test at these surgeries must be treated with some caution. Of those where the test was valid, at only one (73) was the null hypothesis rejected. Thus, as with the comparison of sex distributions, the comparison of mean distances to each surgery reveals little significant difference

Table 3.2

Sample Differences - Males

<u>Surgery</u>	<u>P<sub>1</sub></u>	<u>P<sub>2</sub></u>	<u>P</u>	<u>N<sub>1</sub></u>	<u>N<sub>2</sub></u>	<u>Stat</u>	<u>Sig</u>
6	0.31	0.33	0.33	35	69	-0.21	0.03
10	0.54	0.49	0.51	48	61	0.52	0.60
14	0.36	0.42	0.38	66	19	-0.46	0.65
17	0.40	0.48	0.45	20	31	-0.57	0.57
23	0.35	0.30	0.32	60	113	0.71	0.48
28	0.47	0.43	0.45	38	47	0.36	0.72
32	0.46	0.43	0.45	28	28	0.23	0.82
35	0.52	0.37	0.72	77	136	2.14	0.03
41	0.38	0.43	0.39	103	42	-0.55	0.58
62	0.49	0.42	0.47	90	43	0.78	0.43
63	0.57	0.39	0.45	30	59	1.64	0.10
65	0.67	0.51	0.58	24	35	1.23	0.22
72	0.51	0.38	0.44	87	86	1.62	0.11
73	0.41	0.34	0.38	49	32	0.64	0.52
75	0.46	0.48	0.47	80	86	-0.25	0.80
77	0.40	0.44	0.42	91	112	-0.57	0.57
79	0.44	0.34	0.39	52	47	1.00	0.32
83	0.47	0.37	0.39	15	54	0.71	0.48
87	0.52	0.33	0.40	29	54	1.73	0.08
88	0.41	0.35	0.37	29	77	0.60	0.55
91	0.37	0.38	0.37	139	60	-0.14	0.89
92	0.47	0.41	0.45	76	49	0.67	0.50
94	0.43	0.37	0.39	58	113	0.37	0.71
95	0.44	0.34	0.37	43	108	1.11	0.27
96	0.39	0.33	0.37	41	37	0.50	0.62
97	0.44	0.41	0.42	57	121	0.37	0.71
99	0.63	0.30	0.43	55	83	3.67	0.00

between the SDEB and questionnaire data sets. It may thus be assumed that the two samples capture the distribution of patients' homes about each surgery equally well. Therefore, it does appear that questionnaire respondents not were markedly different from the SDEB sample.

In the absence of further corroborating evidence, the results of this test form the basis for assuming that the other spatial information obtained by the questionnaire survey is representative of dental patients in Edinburgh.

Table 3.3

Sample Differences - Home to Surgery Distances

<u>Surgery</u>	<u>N</u> <u>SDEB</u>	<u>N</u> <u>Quest</u>	<u>Mean</u> <u>SDEB</u>	<u>Mean</u> <u>Quest</u>	<u>Var</u> <u>SDEB</u>	<u>Var</u> <u>Quest</u>	<u>t</u>
6	35	69	3.0	3.7	3.1	4.4	-1.79
10	48	62	2.6	2.9	1.8	2.8	-1.03
14	66	19	4.2	2.0	7.1	5.9	3.38
17	20	31	1.8	3.0	6.5	5.8	-0.28
23	60	114	2.4	2.2	5.8	5.8	0.53
28	38	47	3.1	2.5	4.3	4.7	1.30
32	28	29	2.2	2.1	3.5	3.1	0.21
35	77	137	2.5	2.5	4.8	3.4	0.00
41	103	42	2.9	3.2	3.4	3.8	-0.86
62	90	43	1.6	1.8	1.9	4.2	-0.59
63	30	59	1.7	1.9	1.8	2.7	-0.62
65	24	36	1.4	1.6	1.0	4.5	-0.49
72	87	86	1.6	1.4	3.8	2.3	0.77
73	49	32	2.1	0.9	8.3	2.2	2.45
75	80	89	1.7	1.9	1.7	2.1	-0.95
77	91	112	1.7	1.5	3.4	2.6	0.80
79	52	47	4.2	3.7	4.9	4.8	1.14
83	15	54	1.5	1.9	1.4	4.8	-0.93
87	29	54	2.2	2.5	3.2	3.6	-0.71
88	29	77	3.1	2.7	3.5	3.4	0.98
91	139	60	2.8	3.1	4.9	3.7	-0.97
92	76	49	2.0	1.5	5.3	2.6	1.43
94	58	113	1.9	2.0	5.6	6.0	-0.26
95	43	108	0.5	0.7	0.2	0.7	-1.82
96	41	27	3.5	3.7	8.3	12.4	-0.25
97	57	122	2.5	2.2	3.9	2.4	1.00
99	55	83	2.5	2.3	3.6	3.7	0.61

Three tests, one of which has shown significant differences is scant evidence upon which to base an assessment of the quality of the questionnaire data. Nevertheless, on the basis of these tests one may conclude that the questionnaire data is biased, but not markedly so. In addition, it is reassuring that the known bias can be accounted for in quite sensible terms, and that the underlying distribution of the biased variable (age-group) is similar in both samples. Overall, then, the methodology of the questionnaire survey would appear to have obtained a representative sample.

## Chapter Four

### Dental Care Provision in Edinburgh

The spatial distribution of the supply of dental care in Edinburgh and the implications of this for its accessibility to the population will be considered in this chapter.

The supply of dental care has been shown by O'Mullane and Robinson (1977) to be an important factor in the uptake of dental treatment. They noted from previous studies that the uptake of treatment appeared to be related to social class; members of social classes one and two make relatively more use of dental care facilities than classes three, four and five. Their study refined this general conclusion by examining the role of supply, or 'availability', of dental care. They confined their study to fourteen-year old school children in two unnamed towns in North-West England. One town was well supplied with dentists, in relation to its population size, whilst the other was poorly supplied.

They found that where the dentist/population ratio was low the uptake of dental treatment varied with social class. However, in the town with the good dentist/population ratio the social class gradient in the uptake of dental treatment was much reduced. This suggests that people of 'high' social status will seek dental treatment irrespective of the supply of dental care, whereas people of 'lower' social status increase their uptake of dental treatment in response to increases in the supply. In addition, their results showed that the uptake of dental treatment by the 'high' social status group was higher in the town with the good supply of dental care. This would suggest that the overall level of demand by all social classes varies with the supply of dental care. A possible explanation of this is



that a larger supply of dental care allows a faster 'flow' of patients through the dental care system, thus increasing the overall rate of usage.

It is apparent, therefore, that the availability of dental care to a population may be an important factor in the demand for dental care. This relationship between the volume of supply and the volume of demand has been noted by others (Ashford, 1978; Taylor et al, 1976; Stephens and Bass, 1973). The importance of this for the dental health of different regions is made all the greater by the fact that, unlike general medical practitioners, general dental practitioners are free to locate their practice wherever they wish (Jones, 1977). This, in turn, raises questions of social justice because the general dental service is funded from general taxation. Thus dentists are distributing the benefits of this taxation via the location of their surgeries. By so doing, it is possible they may also be causing spatial variations in the levels of dental health. Ashford (1978) has shown that the greater the dentist/population ratio the smaller is the number of teeth extracted and the greater the number of teeth filled, per patient.

The distribution of dental care at the regional level has been examined several times (eg. Cook and Walker, 1967; Scarrott, 1978; Stephens and Bass, 1973). A general discrepancy has been shown to exist between the South-East and the rest of the UK, with the former having better standards of supply than the latter. However, Scarrott (1978) has noted that the extent of this imbalance is declining. During the period 1963-77, 85 per cent of the net increase in general

dental practitioners in England and Wales occurred outside the south-east. In addition, the distribution of dentists is associated with social class, dentists being more highly concentrated in areas where large proportions of the population are in social classes one and two (Cook and Walker, 1967). The social class factor may, therefore, partly explain the regional pattern. It may also be that the supply of dental care in the south-east is reaching saturation level.

At the intra-urban level insufficient work has been published to identify general patterns. However, Bradley et al (1978), found that accessibility to dental care in Newcastle-upon-Tyne was associated with social class, 'high' social status areas having better accessibility than 'low' social status areas. They also found that the need for treatment was related to accessibility. These findings support those of O'Mullane and Robinson in suggesting that there are spatial and social aspects to the demand for dental care.

It seems essential, therefore, that in a study considering the question of how well the distribution of dental care in Edinburgh serves the population, the socio-economic and spatial relationships between dental surgeries and population should be identified. That is the task of this chapter. In order to achieve this the following questions are tackled:

- 1) what is the spatial distribution of dental care in Edinburgh and what is the associated pattern of accessibility to dental care?
- 2) how is accessibility to dental care distributed throughout the various sub-groups in the population?

In order to answer these questions it is first necessary to measure the accessibility of dental care from different parts of the city.

### Spatial Measures of Supply

Two aspects of supply are examined: the location, and capacity of surgeries. Location is important because it determines the distance patients must travel if they wish to attend a particular surgery. Less obviously, capacity is also important because it controls the number of patients that can be treated at each surgery. Clearly, if demand exceeds supply at a surgery the spatial solution is for excess demand to be allocated to another surgery where supply is greater than demand (Oberg, 1976). In this way capacity can exert a direct influence on the spatial behaviour of dental patients. Thus location and capacity are both directly involved in the accessibility of dental care to the population.

The approach adopted to measuring spatial structure is based upon the 'ranking' of all surgeries, from nearest to furthest, for each cell in the grid of half-kilometre square cells superimposed upon the residential part of Edinburgh. This allows the identification of the nearest, tenth nearest, or any other rank of surgery, to each demand cell. Given that the ranking process is based on the distance from each cell to dental surgeries it is possible to determine the distance it would be necessary to travel from each cell to encompass a given number of surgeries - in other words, how accessible that surgery is to dental care generally. This measure of distance is used as one measure of supply. The distance to any given rank of surgery, for each cell, can be viewed as a measure of spatial

structure and may, therefore, be used to compare access to supply at different points.

The second measure of supply concerns the number of patients that can be treated at each surgery, i.e. the capacity of each surgery. However, unlike distance, measures of capacity are not made to individual surgeries. Instead, it is the amount of capacity available to a cell from a given number of 'nearest surgeries' that is measured. For example, the capacity available from the nearest, the nearest five, the nearest ten, etc., is considered. Such a measure of supply constitutes a measure of the 'opportunity' for obtaining dental care available to each cell. Capacity at each surgery is measured as the number of patients for whom dental returns were made, to the SDEB by dentists practicing at each surgery, during the month of September, 1977. The capacity at any surgery will vary with the number of dentists and the number of patients treated by each dentist, and inversely with the extent of private treatment. The measure at each surgery is presented as a percentage of the total capacity available within the system. Therefore, to any cell, a certain percentage of total system capacity is available from a given number of 'nearest surgeries'. Once again these measures may be compared across all cells.

Thus, there are two measures, one measuring accessibility in terms of distance, the other in terms of capacity. In the analysis later in this chapter they are used in the following way. Surgeries are considered in terms of their rank order, to each cell, and measurements made to given numbers of 'nearest surgeries'. For

example, DIST10 is a measure of the distance from each cell to its tenth nearest surgery, and CAP10 is a measure of the capacity available to each cell at its ten nearest surgeries.

These measures allow the accessibility of each cell to 'local', 'medium distant' or 'distant' elements of the supply structure to be considered. It is important to examine the accessibility profile for a cell to all surgeries in the system rather than, for example, to the nearest twenty or thirty (Breheny, 1978). Failure to do so would result in an incomplete examination of the relationship, which might be restrictive when the relationship between behaviour and structure is examined, because it would not then be possible to consider the effect, if any, that more distant parts of the system have on behaviour. In addition, if all surgeries are not considered the question of 'where to draw the line' arises, and any answer to this question makes assumptions about the spatial behaviour of dental patients, assumptions that have yet to be verified.

Previous studies concerned with the relationship between a set of medical facilities and the served population have adopted one of two approaches. The first concerns accessibility to the system as a whole, deriving measures of 'potential' to health care facilities for all parts of a study area (Bradley et al, 1978; Schneider and Symons, 1971). The other examines spatial behaviour with regard to the nearest one or two facilities to a patient's home (e.g. Bashshur et al, 1971). Neither of these approaches is entirely satisfactory in itself. This is because measures of 'potential' relate locations in an area to the complete set of facilities available to that area.

However measures of 'potential' take into account only a limited number of aspects of the relationship between individual behaviour and the system of supply, i.e. the number of facilities and the distances to them. A measure of the effect of the friction of distance may also be incorporated. Such measures do not allow the possibility that the location of facilities within the urban structure may also have significance. For example, a dental surgery located in the city centre may be much more 'attractive' than a surgery the same distance away but located in the suburbs, because it is close to a lot of shopping opportunities or because it is close to work.

Nevertheless, measures of potential are useful for summarising the results of a study, because they can incorporate any behavioural measures that have been obtained. However, they should not be used to describe the relationship of a set of facilities to a population prior to an examination of the behavioural relationship between supply and demand. This is because any method of relating demand to supply, through a measure of 'potential', implies a particular behavioural response to the distribution of these facilities. That is, a measure of potential explicitly describes a particular type of behaviour, by means of the distance decay exponent. Even when a distance decay exponent of unity is used, in the absence of any empirical evidence, a particular form of behaviour is still being implied. In other words, measures of potential cannot accurately describe the relationship between supply and demand without behavioural data.

While a consideration of the nearest one or two facilities to a particular location may be of interest, it is not sufficient for a study such as this. An analysis of the spatial pattern of use of a system of facilities requires an appraisal of all facilities in the system. The method adopted in this study is to examine the spatial structure of supply, as seen from each residential area. By this means it is hoped that a more thorough analysis of the relationship between spatial structure, accessibility and spatial behaviour may be achieved.

The remainder of this chapter examines the distribution of dental surgeries and capacity in Edinburgh, and their relationship to the population.

#### Dental Surgeries and Accessibility

Prior to examining the distribution of surgeries in Edinburgh, some theoretical implications for accessibility and spatial behaviour arising from alternative distributions of surgeries are discussed.

Consider, for example, geographic search and spatial choice in a situation where surgeries are evenly distributed across a city of regular shape that is never concave outwards, such as a circle or rectangle. In order to encompass a given number of surgeries it is necessary to circumscribe a given area. Thus, for a person living near the centre of the city the distance he travels to the surgery of his choice may be seen as the radius of a circular field of search encompassing the given number of surgeries. However, a person living at the boundary of the city has, in a sense, one half of his 'action



space' removed by the boundary. The directions that this person can travel for dental care are severely constrained. If the boundary at that point is a straight line, then clearly, only half the area of a circle drawn at that point will lie within the city boundary. Thus, the area of the city encompassed by a circle of given radius decreases within a zone adjoining the boundary. A person living at the boundary will, therefore, have to travel a longer distance in order to encompass the same number of surgeries as a person living at the city centre. Given a circle and semi-circle covering the same area the radius of the semi-circle will be 1.4 times that of the circle. Therefore, a person living at the boundary will have to travel 1.4 times as far as the person living in the centre to reach the same number of surgeries, other things being equal.

People living at a distance from the boundary do not necessarily escape its effects. Evenly distributed surgeries minimise the maximum distance that any person will have to travel to his nearest surgery. That is true whether the person lives in the centre or in the suburbs. However, as more distant surgeries are considered, the field of search, when assumed to be circular, will eventually encroach upon the boundary. When this happens the effect will be similar to that experienced by the person living at the boundary. The action space and directions of travel become constrained.

When the most distant surgeries are considered the shape of the study area becomes important in determining the distances travelled. From no matter what area one examines the problem, 'most distant' surgeries will always be those most distant from the centre, i.e. the



peripheral surgeries. If the study area is circular then the difference between the distance travelled to a 'most distant' surgery by a patient from the city centre and one from the periphery is the difference between a radius and a diameter. The patient from the boundary travels twice as far as the city centre patient. Likewise, if the study area was rectangular the 'maximum distance' would be the length of the diagonals, whilst the minimum 'maximum distance' would be half this length. For any given area, therefore, the shape of the area determines the potential minimum and maximum 'maximum distances' travelled by patients.

Any distortion of the basic assumptions will, clearly, be important in terms of accessibility within the study area. For example, if the boundary is not a straight line but is, say, concave inwards then this would further reduce the area of the city encompassed by a circle drawn at the boundary. As a result, the distance travelled by residents living at the boundary will be increased still further. Another modification could be where the area in which surgeries are distributed involves only the core of the city, leaving a band around the core devoid of surgeries. This would still further increase the distance that suburban patients have to travel to encompass a given number of surgeries.

A further development of this last situation could be where surgeries are not evenly distributed within the area of the city that they occupy, but instead are concentrated in the centre with few near the periphery. This situation will favour residents of the city centre by reducing the distance they need travel to reach a given number of

surgeries. The city centre becomes a 'surgery rich' area with opportunities for obtaining dental care being concentrated there. Suburban patients are, of course, further disadvantaged.

The situation just described is generally applicable to Edinburgh (Figure 3.1), and is also probably true for most British cities. An uneven distribution of surgeries exists, with a high concentration in the city centre. And for only limited stretches can the boundary be termed straight, generally it is concave inwards. Central and suburban parts of Edinburgh have been identified on the basis that grid cells whose mid-point is three kilometres or less from the city centre (taken to be the junction of The Mound and Princes Street) are central and those greater than this distance are suburban. The area circumscribed by this three kilometre radius is largely coincident with the 'dense built-up' area identified on Bartholomew's map of Edinburgh and used in chapter three as part of the spatial framework for sampling surgeries in the questionnaire survey. Of the ninety-six surgeries, only 27 are located in the suburbs. This suggests that distance from the city centre will be a good indicator of a person's accessibility to dental care.

Some of these implications, measured in terms of distance to increasing numbers of nearest or 'local' surgeries for each residential area in Edinburgh, are illustrated in Figures 4.1 - 4.3. Those areas where there are no dental surgeries, i.e. areas with above average distance to the nearest surgery, are clearly picked out (Figure 4.1). It can be seen that such areas are to found only in the

Figure 4.1 Distance to the nearest surgery from each cell

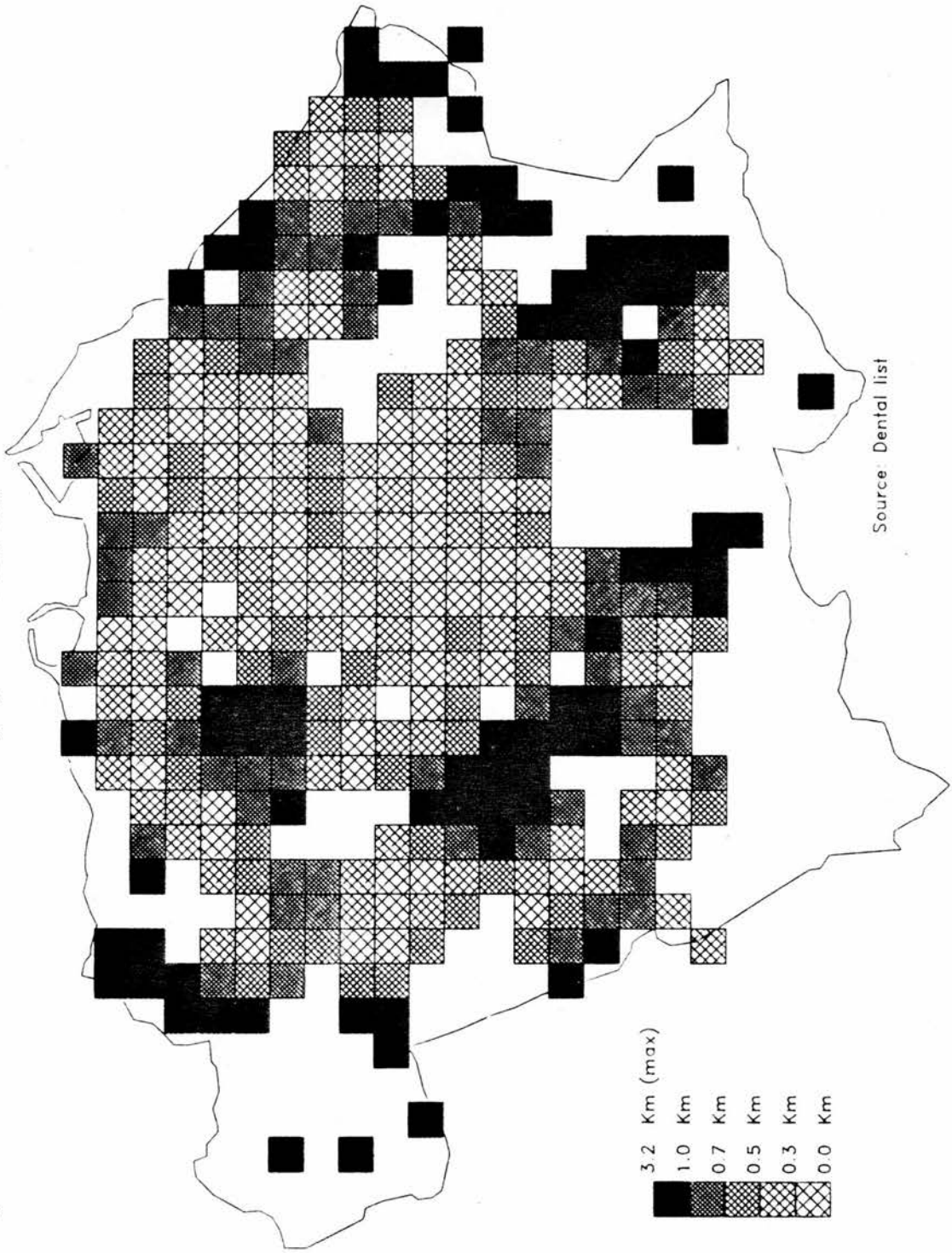


Figure 4.2 Distance to the fifth nearest surgery from each cell

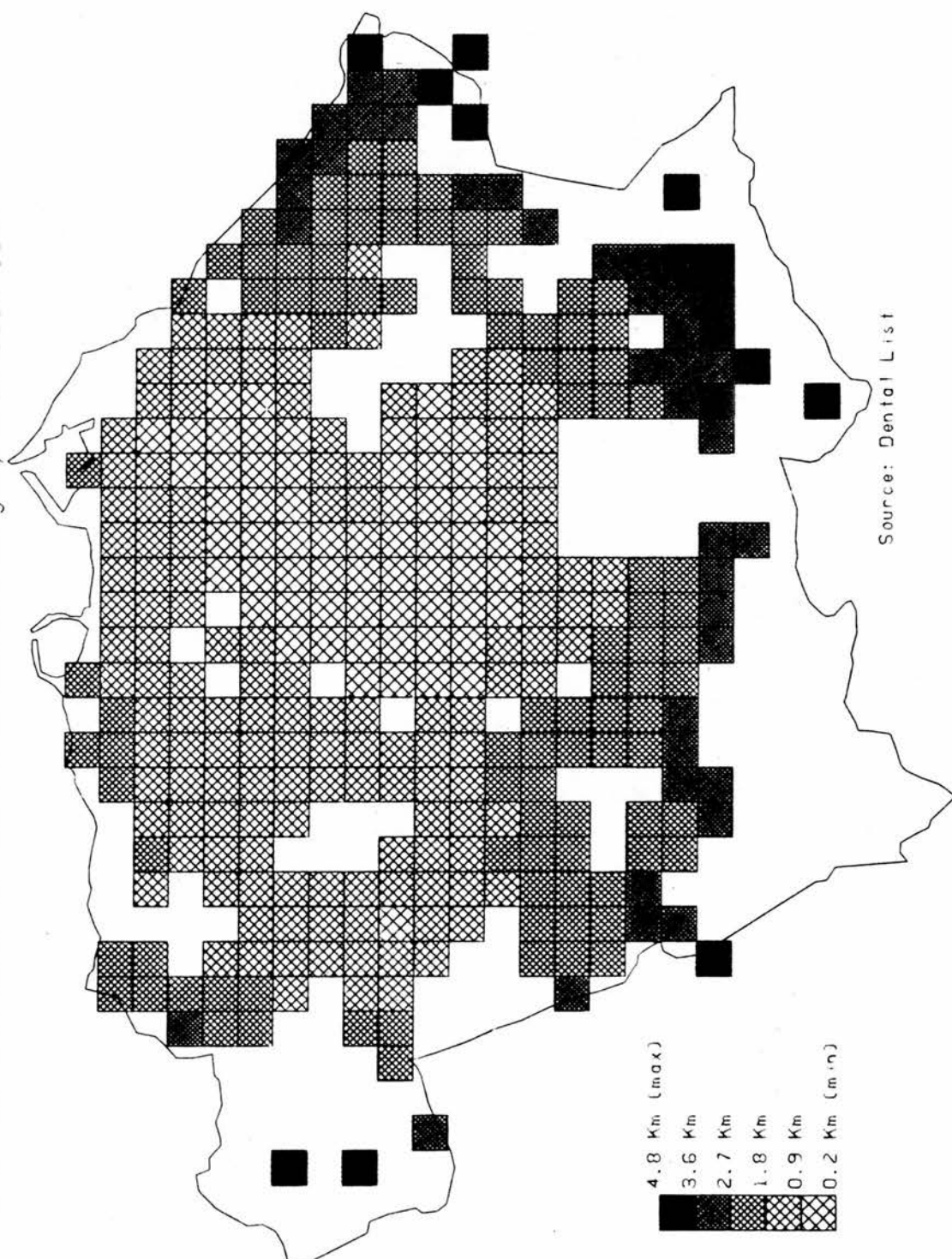
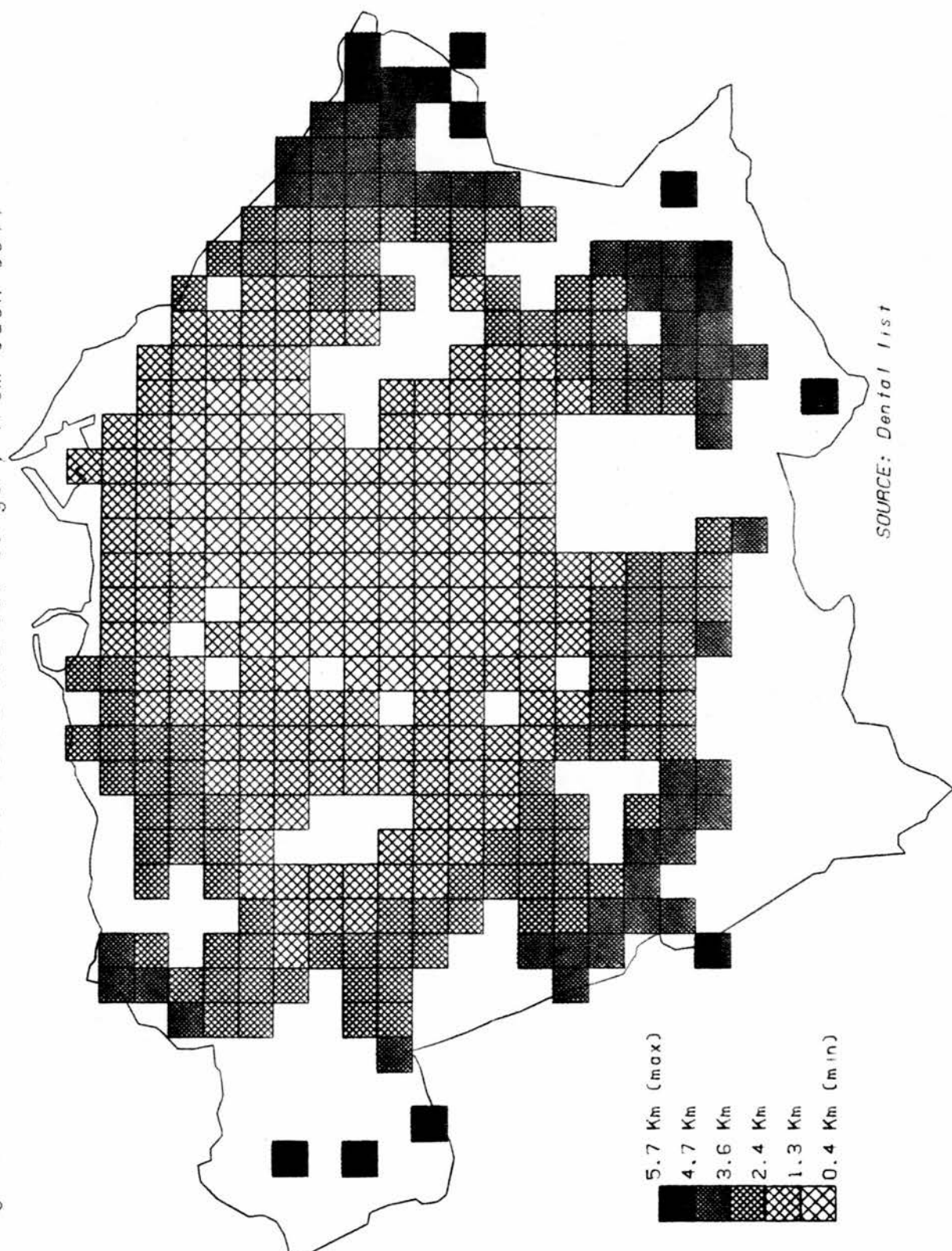


Figure 4.3 Distance to the tenth nearest surgery from each cell



suburbs - a consequence of the concentration of surgeries in the city centre. Of course, some suburban areas are as close to their nearest surgery as the central areas, but these are relatively few.

The effect of both the distribution of surgeries and the influence of the study area boundary 'forcing' people in the suburbs to travel longer distances than people from the city centre is illustrated in Figures 4.2 and 4.3. As the number of nearest surgeries considered increases from five to ten the pattern crystallises to a situation of maximum accessibility in the centre, decreasing outwards to a minimum at the periphery. Clearly, to exercise the same amount of choice residents of suburban areas face longer distances than residents at the city centre.

The implications for spatial behaviour of attending particular ranks of surgery are worth considering at this point. Most surgeries will be a 'nearest', 'fifth nearest', or 'tenth nearest' surgery to some cells in Edinburgh. If desire lines were drawn to represent the choices of patients attending these ranks of surgery the likely pattern to emerge would be one showing many local centres across the whole of the city. However, because of the concentration of surgeries in the central area it is likely that, from no matter which residential area one cares to choose, surgeries of 'middle rank', i.e. ranks 20 - 50, will tend to be located in the city centre. People living in the city centre need travel only very short distances to reach relatively high ranks of surgery, say rank 50. In other words, they have a lot of opportunity available to them within quite short distances. People in the suburbs will also find most of



their middle rank surgeries in the city centre. Hence the spatial pattern of patients attending these ranks of surgery will show a general focus on the city centre.

From no matter what location, the furthest facility will always be found on the periphery of the distribution of facilities. Thus, patients attending one of the most distant surgeries will always travel to the periphery. Furthermore, if the patient resides in a suburban area then he must undertake a journey across the city to attend one of these surgeries.

The distribution of capacity is presented in Figure 4.4. Large and medium sized surgeries are shown to occur quite commonly in both central and suburban areas. Small surgeries, on the other hand, are most numerous in the city centre with relatively few in the suburbs. The implication of this is that, for any given number of nearest surgeries, people living in the city centre will face smaller amounts of dental care capacity than suburban residents. A cross-tabulation of surgeries by size and location (Table 4.1) confirms that in the suburbs there is a smaller proportion of small surgeries and, consequently, a larger proportion of large surgeries than in the city centre.

The spatial patterns of the availability of local surgery capacity (Figures 4.5 and 4.6) are less easy to interpret than those of distance. However, it does appear that cells facing large amounts of capacity from any given number of nearest surgeries are to be found mainly in the suburbs. Small amounts of capacity are found in a 'Y'

Figure 4.4 The percentage of total capacity available at each surgery

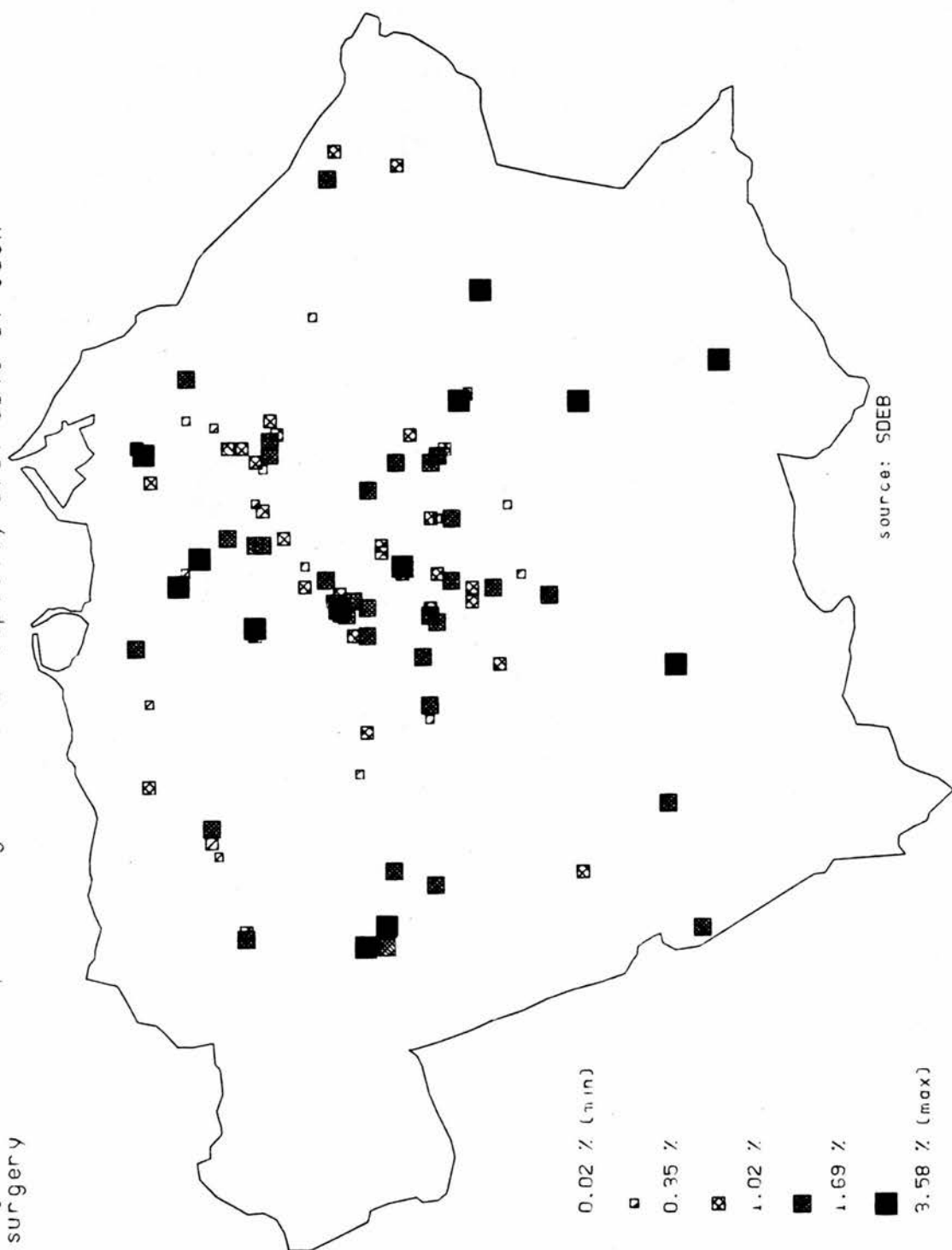




Figure 4.5 Capacity available to each cell from its nearest surgery

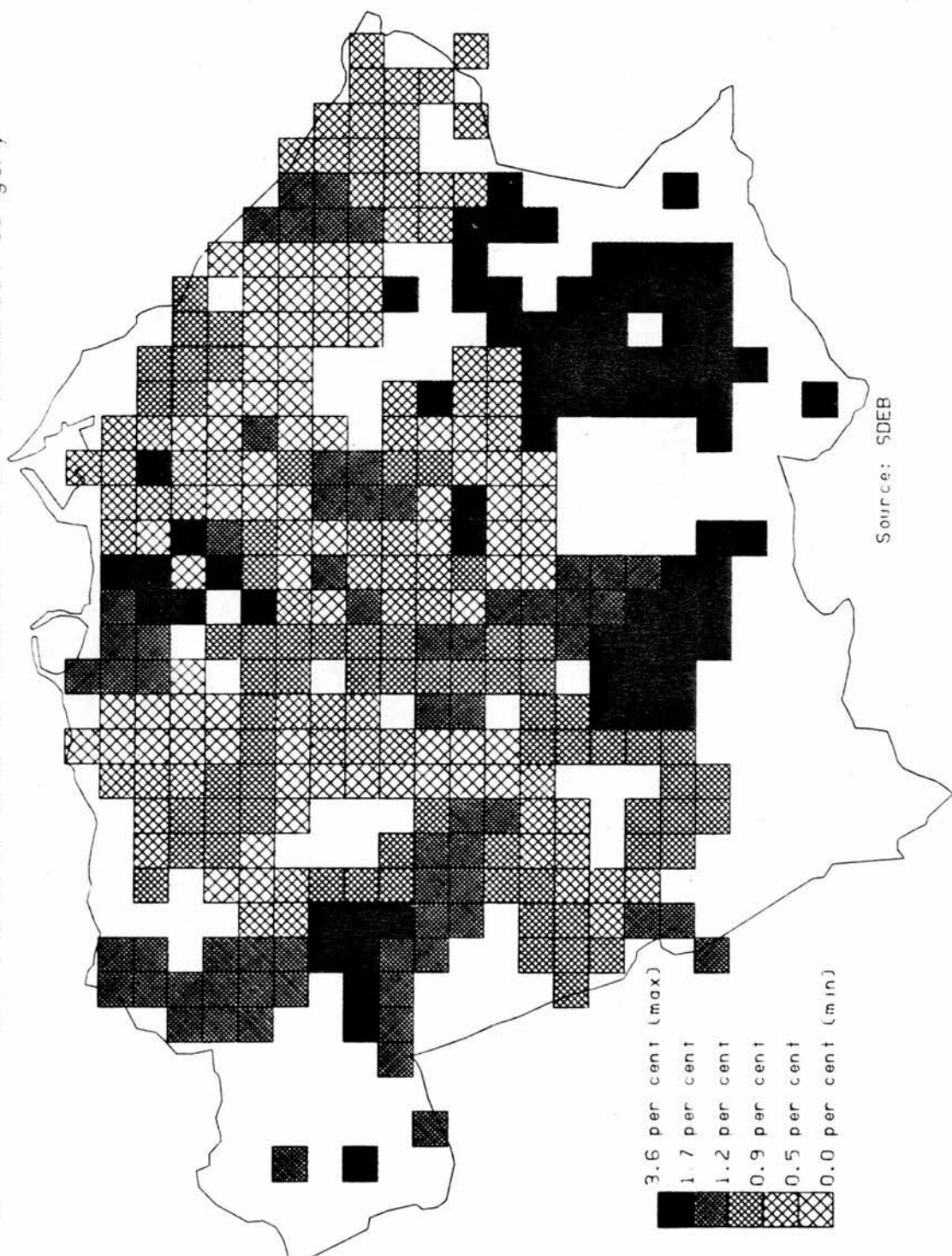
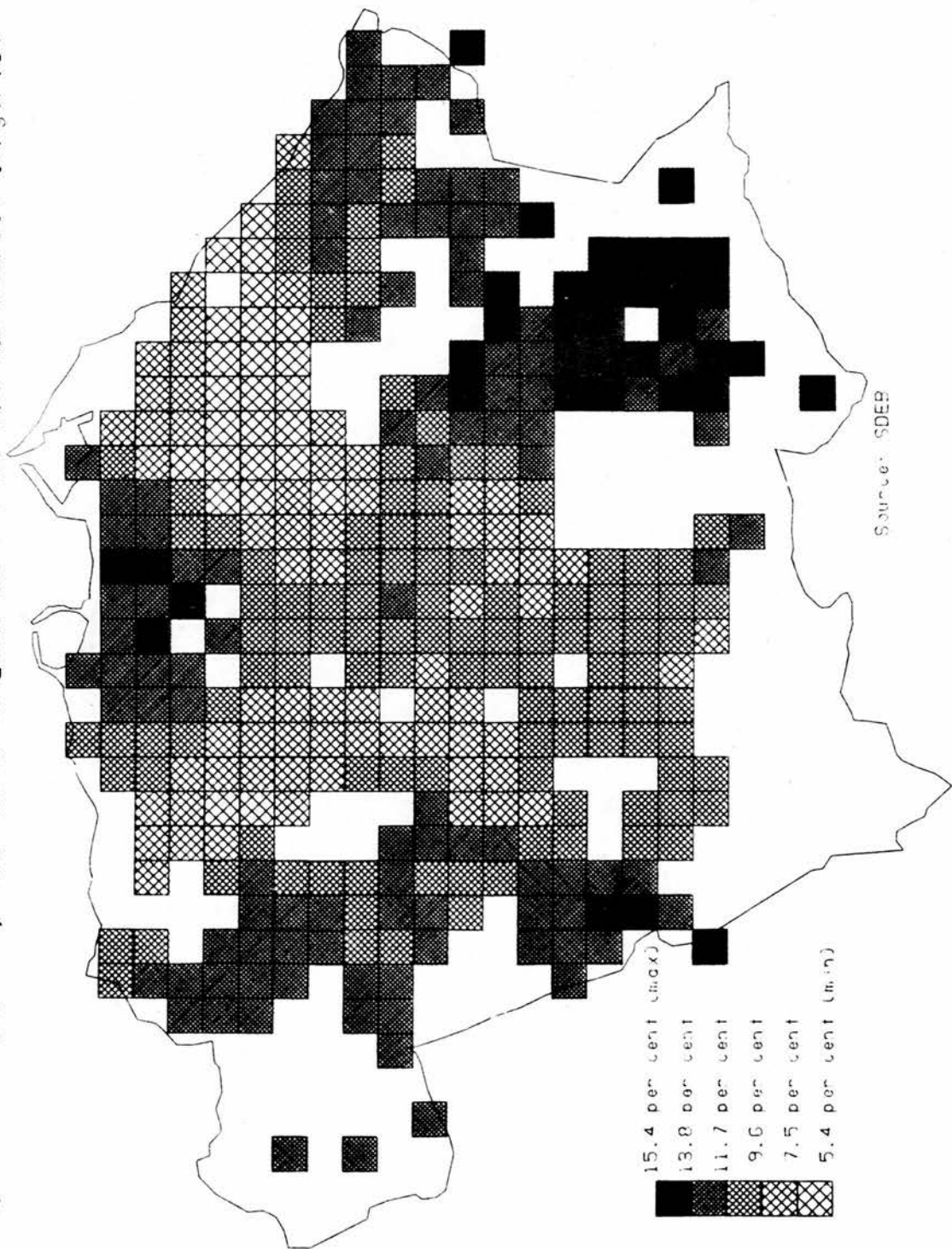


Figure 4.6 Capacity available to each cell from its ten nearest surgeries



shaped area extending right across the residential area of the city

Table 4.1

Comparison of the size distribution of surgeries in central and suburban Edinburgh

<u>Surgery Size</u> (% of total)	<u>Centre</u>	<u>Suburbs</u>	<u>Total</u>
	!		
	11	4	15
	15.9%	14.8%	
1.7 (+1 S.D.)	-----!	-----	
	30	9	39
	43.5%	33.3%	
1.0 (mean)	-----!	-----	
	23	10	33
	33.3%	37.0%	
0.3 (-1 S.D.)	-----!	-----	
	5	4	9
	7.2%	14.8%	
	-----!	-----	
Total	69 99.9 !	27 99.9	96

from north to south, and including suburban and central areas. One would expect low capacities to be found in the centre, given the distribution of surgery capacities. However, the extremities of the 'Y' shape, in the suburbs, reflect the distribution of surgeries themselves. These areas tend to be relatively devoid of surgeries. Therefore one must look towards the centre to find the ten nearest surgeries of these areas. And these, of course, tend to be small.

The main conclusion to be drawn from the analysis so far is that suburban residents generally face longer distances to, and larger amounts of capacity at, any given number of local surgeries than do city centre residents.

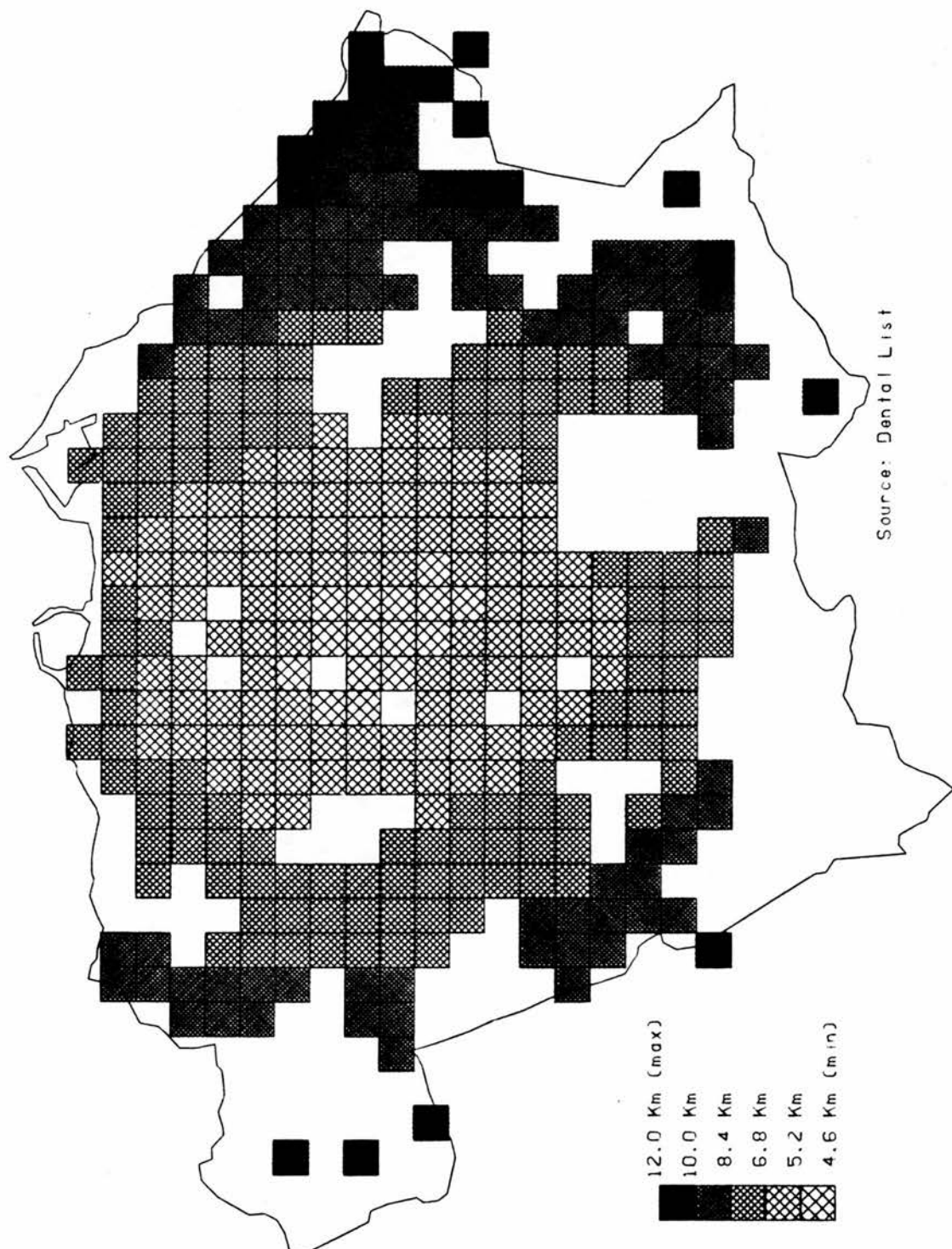
Strong positive correlations between distance from a cell to different numbers of nearest surgeries and the distance of the cell

from the city centre reflect the relative distribution of surgeries and residential locations within the city (Table 4.1). Correlations at the extremes of the range are weaker than those between DIST20-DIST80 inclusive. This suggests that additional factors are involved at the extremes that do not have an effect in the middle-of-the-range. At the low end the explanation is that some suburban residents are as close to their nearest and tenth nearest surgeries as central residents. Below average distances to the tenth nearest surgeries are to be found close to the western edge of the built-up area (Figure 4.6). Thus, whilst distance from the city centre is a good indicator of the distribution of distances to 'local' surgeries, there are still subtle and important variations caused by specific local variations in the distribution of surgeries. Only when access to a wider choice of surgeries is considered does distance from the city centre become important.

The distribution of distances to ninetieth ranked surgeries (Figure 4.7) shows that it is the configuration of the built-up area that influences the distribution of distances to 'furthest' surgeries. The built-up area is roughly rectangular in shape, with the longest axis east-west. Areas in the extreme east and west of the city therefore face the longest distances to surgeries.

The capacity available to any cell from any given number of nearest surgeries is quite strongly and positively correlated with distance from the city centre (Table 4.2). This indicates that the further the cell is from the city centre the more likely it is to face relatively

Figure 4.7 The distance dental patients would have to travel in order to attend their ninetieth nearest surgery



large amounts of capacity at any given number of nearest surgeries.

Table 4.2

Correlation coefficients showing the strength of association of the distance to, and capacity available from, increasing numbers of nearest surgeries for each cell with the distance of the cell from the city centre.

DIST10	0.892	CAP10	0.492
DIST20	0.959	CAP10	0.507
DIST30	0.955	CAP30	0.527
DIST40	0.946	CAP40	0.557
DIST50	0.950	CAP50	0.602
DIST60	0.970	CAP60	0.594
DIST70	0.974	CAP70	0.462
DIST80	0.926	CAP80	0.441
DIST90	0.749	CAP90	0.260

The measure of distance is along a straight line and that of capacity is the percentage of total capacity available in the system.

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Nevertheless, the size of the correlations shows that the relationships are not as strong as those for distance. This is largely because the pattern of capacity available to each cell does not focus on the central area (Figures 4.5 - 4.6) as does the distribution of distances.

#### Accessibility and the population

Having established the pattern of accessibility to dental care in Edinburgh, it is important to identify how this pattern relates to the population. To this end accessibility to dental care will be described for:

- a) the population generally;
- b) socio-economic categories of the population;
- c) housing tenure.

Before proceeding it is worth noting that there are two possible ways

by which these factors may be associated with the distribution of dental surgeries. These relate to alternative methods of quantifying the various groups.

The first of these is to measure the number of people in each category in each cell. The use of absolute values relates dental care to the number of people in each category. Such measures therefore contain information on the 'quantity' of potential demand in an area.

The second measure is the percentage of the population in each cell that is in each category. These percentage figures relate dental care to the socio-economic characteristics of different areas, and are therefore concerned with the 'nature' or 'quality' of demand in an area.

### Population

The distribution of population in Edinburgh, aggregated upwards from enumeration districts to half-kilometre square cells, is shown in Figure 4.8. The highest densities are found around the city centre and in certain suburban areas, mainly to the north (Leith) but also in isolated pockets to the east and west. Access to dental care is negatively associated with the distribution of population (Table 4.3). Thus when the population in an area is relatively large the distance to dental care is relatively short. On the other hand, the correlation coefficients are not particularly strong, none being greater than 0.3.



Figure 4.8 The distribution of population in Edinburgh

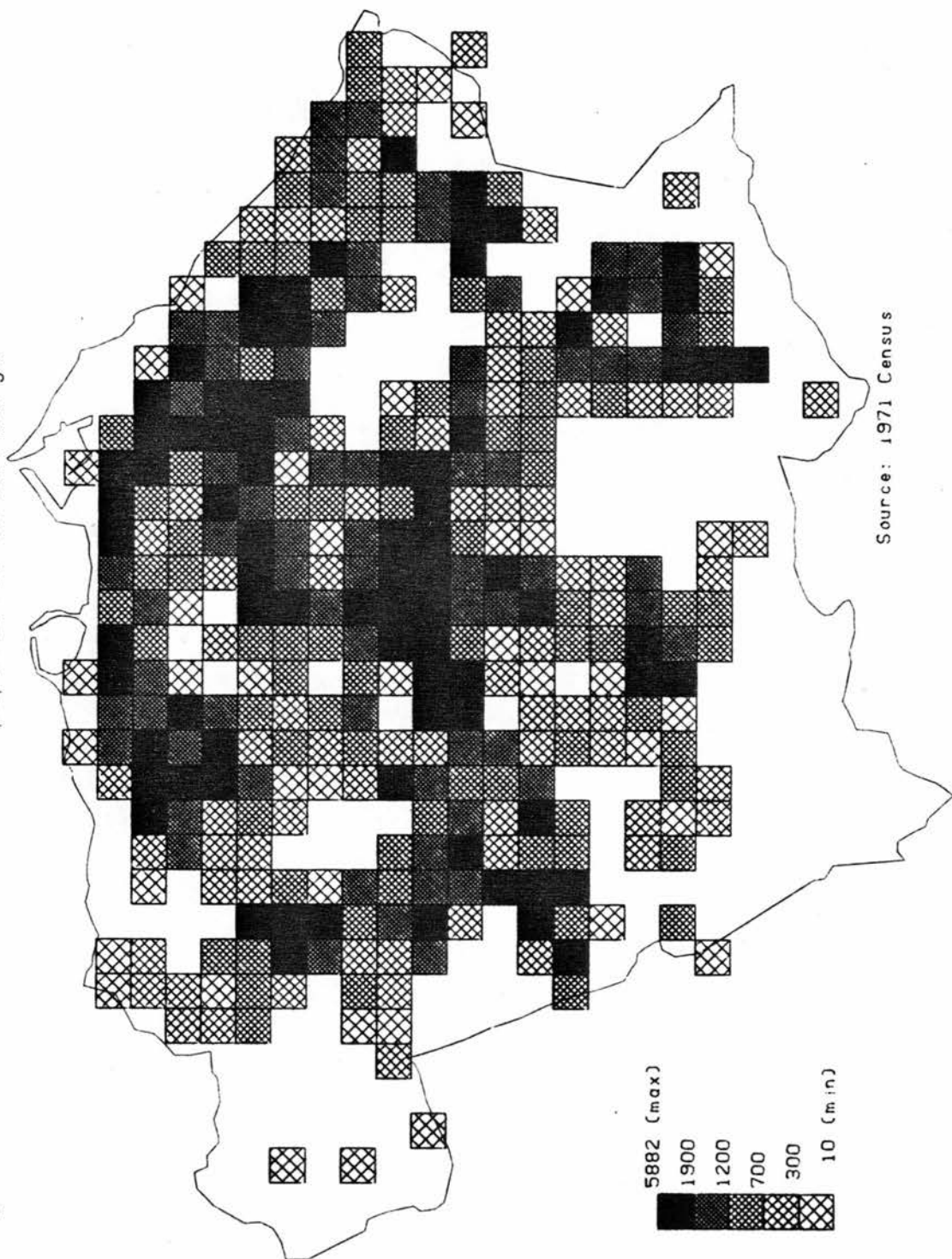




Table 4.3

Correlation coefficients showing the strength of association between the size of the population in each cell and the distance to, and capacity available from, increasing numbers of nearest surgeries.

<u>Population</u>		
DIST10	-0.281	!
DIST20	-0.282	!
DIST30	-0.277	!
DIST40	-0.268	!
DIST50	-0.268	!
DIST60	-0.271	!
DIST70	-0.272	!
DIST80	-0.256	!
DIST90	-0.179	!
DIST99	-0.159	!

---

This suggests either that there are other factors involved in the distribution of surgeries or that the association is coincidental. The correlation coefficients for the relationship with distance show that surgeries tend to be located close to centres of population. However, part of the significance of these figures may simply reflect the fact that both population and surgeries are concentrated in and around the city centre. The correlations between population and capacity are negative. The reason being that large surgery capacities are available in the suburbs whilst population is largest in the centre.

This distribution of surgeries and capacities relative to the population can be explained in the following way. Irrespective of population distribution surgeries located in the city centre achieve high accessibility to the whole population. In addition, surgeries located in the centre are adjacent to many work and shopping opportunities. This undoubtedly makes central surgeries more 'attractive'. It makes sound economic sense therefore to reduce the

risk of business failure by locating in the city centre. And this is especially true for small scale single handed surgeries that would most feel the impact of fluctuations in demand. Indeed, centrally situated surgeries may be virtually assured a steady stream of business.

The suburbs, on the other hand, do offer most scope for new dental surgery ventures, in that demand may be 'captured' before it is directed to the city centre. Suburban surgeries, by definition, are not highly accessible to the whole population. In business terms this means that they are less likely to be able to withstand competition from others because their catchment areas are relatively limited. Competing surgeries would quickly result in the over supply of dental care and the possible bankruptcy of dentists. Consequently suburban surgeries are more likely to be isolated than concentrated together. This in turn means that suburban surgeries may exercise a certain degree of monopoly control over suburban demand. Because of this, these surgeries may expand to cater for relatively large amounts of demand. That is, they will have relatively large capacities.

### Housing Tenure

There appears to be a clear segregation of council and owner-occupied housing in Edinburgh (Figures 4.9 and 4.10). Also, areas with large percentages of council housing are found close to the periphery. Most furnished and unfurnished rented accommodation is found in the centre, though some unfurnished accommodation may be found throughout the city (Figures 4.11 and 4.12).

Figure 4.9 The percentage of private households which are owner occupied

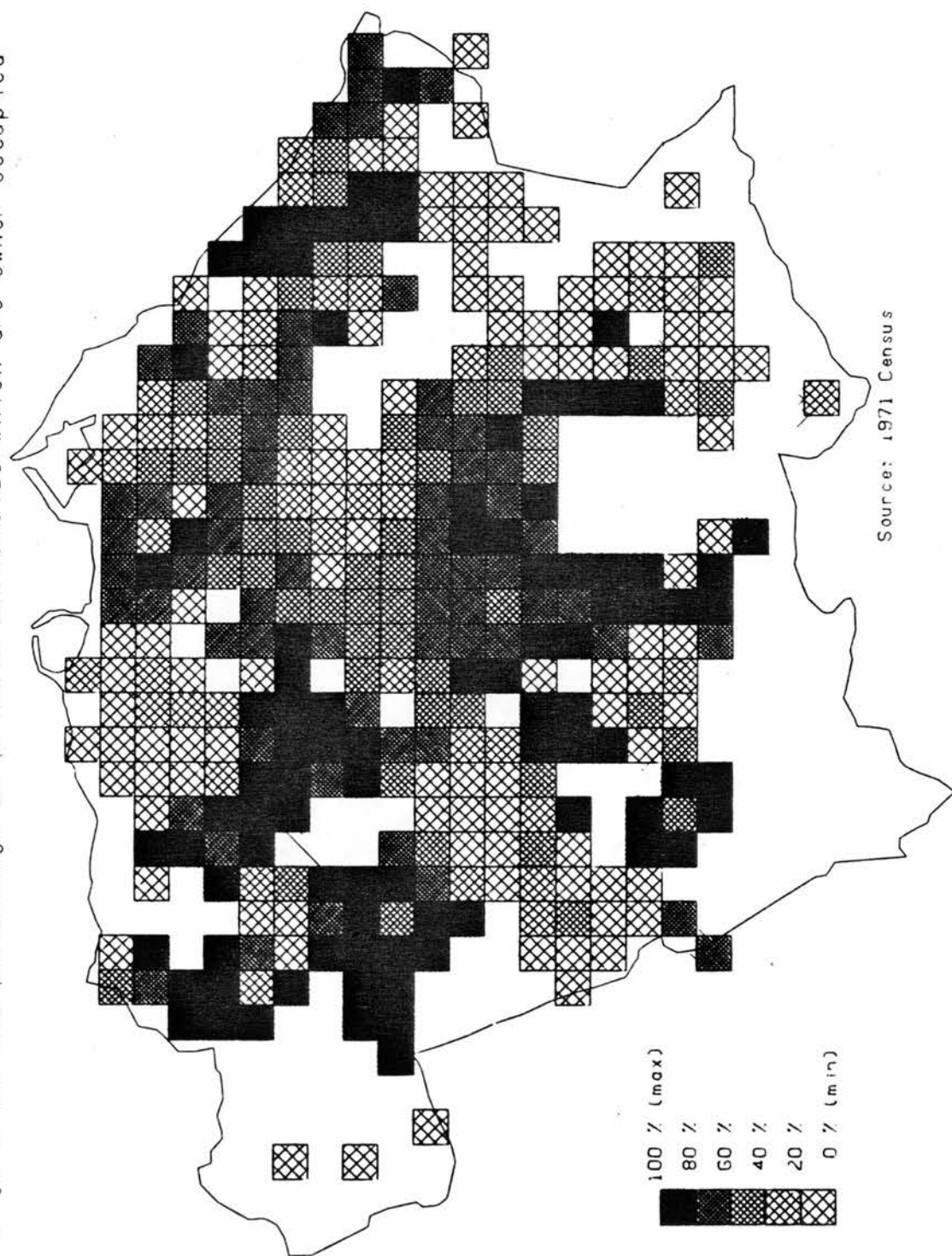


Figure 4.10 The percentage of private households which are council owned

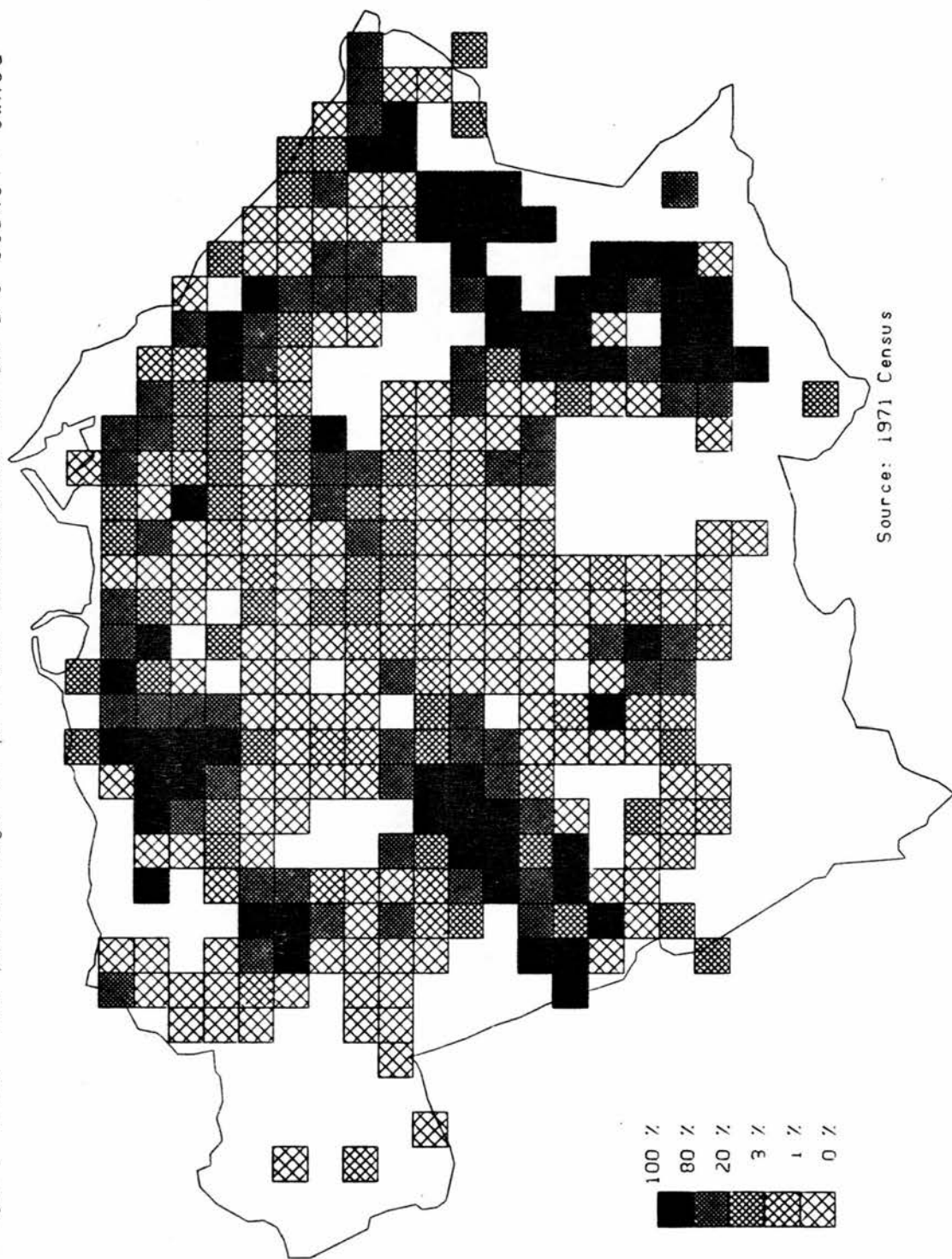


Figure 4.11 The percentage of private households which are rented furnished

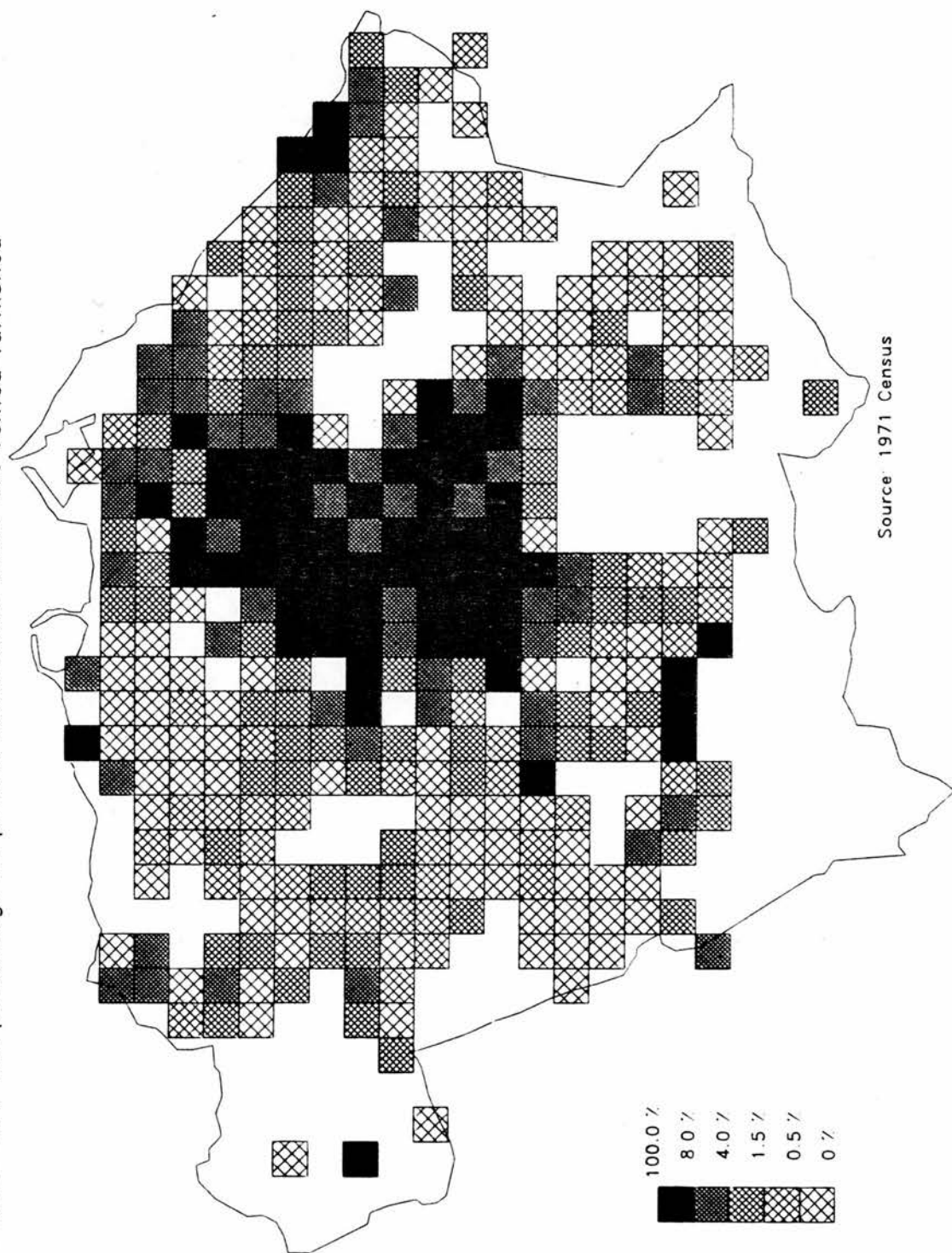
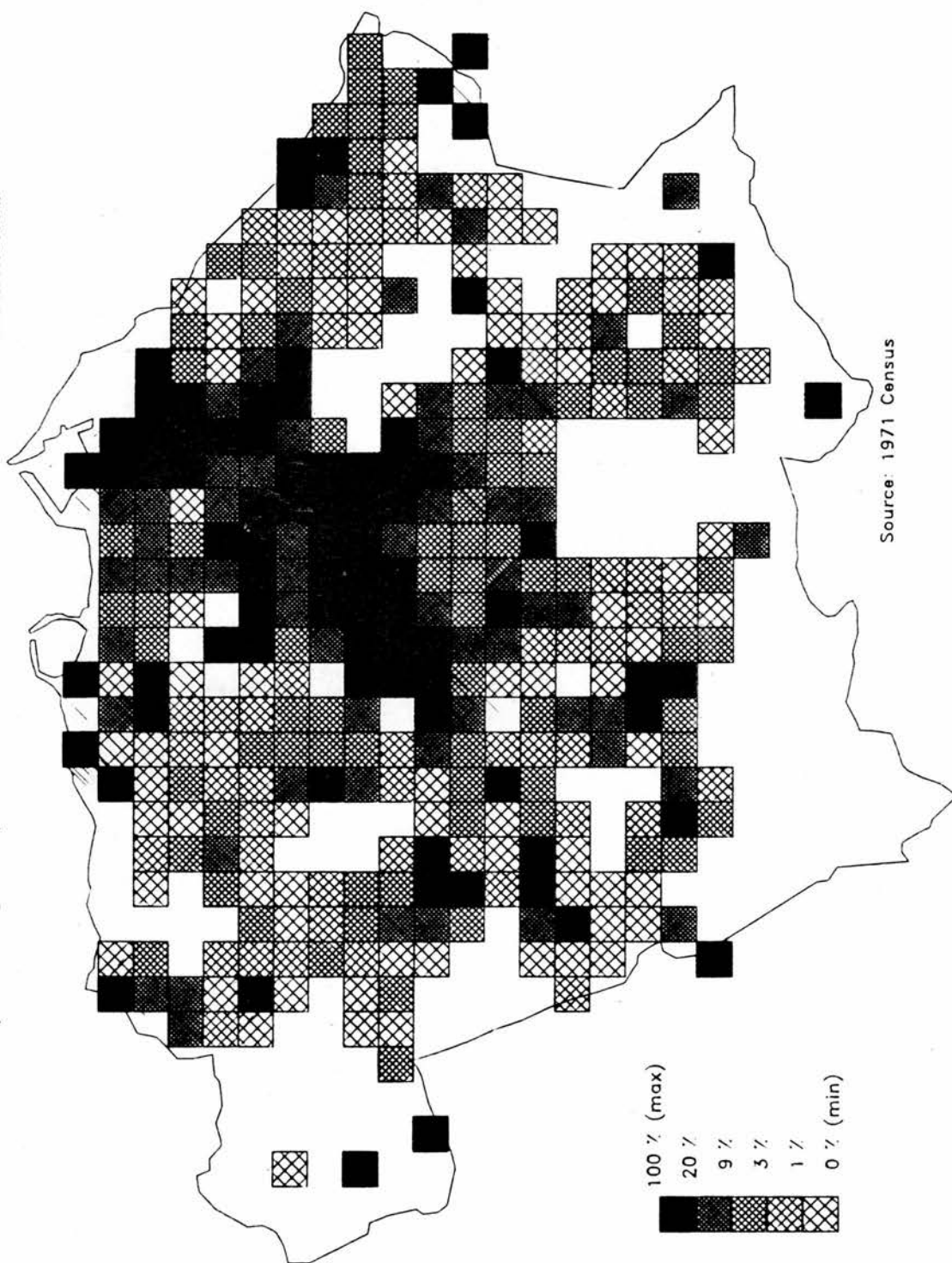


Figure 4.12 The percentage of private households which are rented unfurnished





In a very striking association (Tables 4.4 and 4.5) council accommodation is found to be poorly situated in terms of distance to dental care, in contrast to the other types of tenure. When the number and/or percentage of council houses in an area is large, the distance to any number of nearest surgeries is also large, whereas the reverse is true for the other types of tenure.

The bulk of council accommodation in Edinburgh is situated in large suburban estates. It appears that, for whatever reasons, dentists tend not to locate their surgeries in or close to such council estates. It is important to note the difference in strength of correlation, for both tables, between DIST1 and DIST10. It will be seen that the DIST1 correlations are much weaker than those with

Table 4.4

First order partial correlation coefficients showing the strength of relationship between the number of households of each type of tenure in each cell and the distance from each cell to increasing numbers of nearest surgeries - controlling for the total number of households in each cell.

	<u>Own.occ</u>	<u>Council</u>	<u>Ren.un.</u>	<u>Ren.furn.</u>
DIST1	-0.137	0.172	-0.082	-0.179
DIST10	-0.285	0.353	-0.176	-0.335
DIST20	-0.276	0.351	-0.177	-0.354
DIST30	-0.250	0.319	-0.149	-0.348
DIST40	-0.249	0.319	-0.148	-0.358
DIST50	-0.233	0.310	-0.159	-0.350
DIST60	-0.220	0.302	-0.156	-0.363
DIST70	-0.216	0.285	-0.137	-0.332
DIST80	-0.219	0.285	-0.143	-0.311
DIST90	-0.257	0.311	-0.133	-0.317
DIST99	-0.232	0.286	-0.087	-0.380

---







Table 4.5

Correlation coefficients showing the strength of association between the percentage of each cell's households in each type of tenure and the distance from each cell to increasing numbers of nearest surgeries.

	<u>%Own.occ</u>	<u>%Council</u>	<u>%Ren.un.</u>	<u>%Ren.furn.</u>
DIST1	-0.141	0.127	-0.061	-0.200
DIST10	-0.151	0.257	-0.100	-0.306
DIST20	-0.127	0.244	-0.117	-0.323
DIST30	-0.106	0.222	-0.110	-0.314
DIST40	-0.110	0.231	-0.109	-0.326
DIST50	-0.092	0.218	-0.116	-0.326
DIST60	-0.077	0.208	-0.122	-0.337
DIST70	-0.077	0.190	-0.107	-0.303
DIST80	-0.090	0.200	-0.087	-0.295
DIST90	-0.171	0.269	-0.062	-0.289
DIST99	-0.132	0.221	-0.022	-0.337

DIST10. This suggests that though council housing is quite far from the nearest surgery they are much further from subsequent 'local' surgeries, i.e. council estates appear to be served by 'lone' surgeries. To an extent this relates to the earlier point concerning the monopoly power of suburban surgeries. It may also reflect the fact that people in 'lower' social status categories of the population tend to avail themselves of dental care rather less than people in the 'higher' social status categories, thus generating less demand for dental care services (see Chapter Five).

Clearly these correlations simply reflect the relative distributions of each type of tenure and of surgeries. The strongest correlations occur with council and rented-furnished accommodation. This is because both these tenure types have relatively discrete distributions. Owner-occupied and rented-unfurnished accommodation, on the other hand, have generally weaker correlations because of their more dispersed distributions.

Although these observations may suggest that the association between tenure and distance to dental care can be explained in terms of spatial structure, there is an alternative interpretation. Dental surgeries are operated as private businesses. As such all the necessary requirements for providing dental care are usually found in the 'market place', including accommodation. It must be borne in mind that, to the principal dental surgeon, surgery premises represent a substantial investment. Often the surgery will be part of his own house. Alternatively, it may be property bought specifically as a surgery. In either case it is unlikely to be located in council property. Dentists normally earn incomes high enough to enable them to live in high amenity property of their own choosing. Also, should the necessity arise, the surgery may be sold to liquidise assets. In council accommodation this would not be possible.

In contrast with the distance to dental care, the capacity available to areas of mainly council accommodation, from increasing numbers of nearest surgeries, is large (Tables 4.6 and 4.7). Because the strength of the association is greatest for the nearest forty surgeries, it seems that central surgeries in the same sector of the city as council accommodation tend to be large, this being especially true of surgeries relatively close to council accommodation.

Owner occupied housing displays negative and weak associations with the distance to the lower numbers of nearest surgeries (Tables 4.8 and 4.9). This would suggest that the capacity of surgeries to deliver NHS dental care in the immediate vicinity of owner-occupied areas

Table 4.6

First order partial correlation coefficients showing the strength of relationship between the number of households of each type of tenure in each cell with the capacity available to each cell from increasing numbers of nearest surgeries - controlling for the total number of households in each cell.

	<u>Own.occ</u>	<u>Council</u>	<u>Ren.un.</u>	<u>Ren.furn.</u>
CAP10	-0.196	0.220	-0.107	-0.144
CAP20	-0.169	0.211	-0.152	-0.108
CAP30	-0.164	0.220	-0.200	-0.077
CAP40	-0.082	0.171	-0.206	-0.122
CAP50	0.015	0.089	-0.172	-0.141
CAP60	-0.012	0.087	-0.105	-0.175
CAP70	0.037	0.015	-0.041	-0.123
CAP80	-0.101	0.135	-0.088	-0.113
CAP90	0.018	0.004	-0.057	0.035

Table 4.7

Correlation coefficients showing the strength of relationship between the percentage of each cell's households in each type of tenure with the capacity available to each cell from increasing numbers of nearest surgeries.

	<u>%Own.occ</u>	<u>%Council</u>	<u>%Ren.un.</u>	<u>%Ren.furn.</u>
CAP10	-0.178	0.248	-0.087	-0.187
CAP20	-0.095	0.230	-0.149	-0.188
CAP30	-0.079	0.226	-0.252	-0.145
CAP40	0.073	0.110	-0.274	-0.161
CAP50	0.171	0.035	-0.271	-0.176
CAP60	0.151	-0.018	-0.228	-0.137
CAP70	0.147	-0.065	-0.139	-0.051
CAP80	-0.036	0.134	-0.155	-0.097
CAP90	0.056	-0.011	-0.143	0.019

tends to be relatively small. An explanation of this could be that more of the treatment carried out by dentists in these areas is private, thus reducing the amount of NHS dental care capacity. Beyond the lower numbers of nearest surgeries the relationships become generally positive, especially for the percentages. Hence central surgeries in sectors of the city with large numbers, or large percentages, of owner-occupied housing tend to be relatively large.

Rented housing, both furnished and unfurnished, is shown to be

negatively related to the capacity available from any number of nearest surgeries (Tables 4.6 and 4.7). In other words, large amounts of these types of accommodation tend to be far from large surgeries. This would be expected given their general concentration in the city centre.

In general the relationship between tenure and access to dental care can be summarised as follows. Areas with large amounts of owner-occupied, rented furnished and rented unfurnished housing seem to be served by numerous small surgeries close by, whereas council accommodation appears to be served by large, isolated surgeries.

#### Socio-economic characteristics

Using absolute values (Table 4.8) it was found that, in terms of access to care, the distribution of surgeries favours people in SEC's 1 and 2 whilst those in SEC's 3 and 4 are disadvantaged. When the number of people in SEC's 1 and 2 is large the distance to any number of nearest surgeries is relatively small. Conversely, when there are large numbers in SEC's 3 and 4 the distances are relatively large. Thus, people in SEC's 3 and 4 are disadvantaged relative to those in SEC's 1 and 2. The percentage values, on the other hand, present a somewhat different picture (Table 4.9). Not all coefficients are very different from zero and the majority of those that are concern SEC 2 and are negative in nature, though there are some positive correlations with SEC 3. Thus, dental surgeries are spatially associated with areas where there are high percentages in SEC 2 and relatively far from areas with large percentages in SEC 3. Hence, it appears that the location of dental surgeries favours areas with

Table 4.8

First order partial correlation coefficients showing the strength of relationship between the number of people in each socio-economic category in each cell and the distance to increasing numbers of nearest surgeries - controlling for total population.

	<u>SEC1</u>	<u>SEC2</u>	<u>SEC3</u>	<u>SEC4</u>
DIST1	-0.129	-0.204	0.222	0.145
DIST10	-0.201	-0.213	0.274	0.211
DIST20	-0.162	-0.219	0.279	0.171
DIST30	-0.161	-0.219	0.276	0.174
DIST40	-0.170	-0.226	0.288	0.183
DIST50	-0.152	-0.210	0.272	0.166
DIST60	-0.138	-0.188	0.264	0.151
DIST70	-0.138	-0.182	0.254	0.154
DIST80	-0.161	-0.178	0.252	0.164
DIST90	-0.253	-0.223	0.308	0.223
DIST99	-0.246	-0.205	0.326	0.192

---

large numbers of people in SEC's 1 and 2, and to a lesser extent favours areas with the largest part of local demand having an SEC 2 hue.

The relationship between surgery capacity and the 'number' of people in each SEC is marked by a general lack of 'non-zero' correlations (Table 4.10). Thus the distribution of surgery capacity does not appear to be related to the distribution of the number of people in each SEC.

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However, the relationship between capacity and the SEC 'percentage' values is rather more definite (Table 4.11). Here there are many more 'non zero' relationships. Most concern surgeries between ranks 30 - 70, i.e. that range where many of the 'next nearest' surgeries will be centrally located. As was the case with absolute values, available capacity at 'local' surgeries (ranks 1 - 30) tends not to be associated with the socio-economic characteristics of the population of each area. When the capacity from larger numbers of surgeries (40

Table 4.9

Correlation coefficients showing the strength of relationship between the percent of the population in each socio-economic category in each cell and the distance to increasing numbers of nearest surgeries.

	<u>%SEC1</u>	<u>%SEC2</u>	<u>%SEC3</u>	<u>%SEC4</u>
DIST1	0.077	-0.137	0.058	-0.062
DIST10	-0.002	-0.139	0.104	0.001
DIST20	0.057	-0.146	0.088	-0.057
DIST30	0.058	-0.145	0.083	-0.058
DIST40	0.046	-0.156	0.100	-0.044
DIST50	0.062	-0.142	0.085	-0.056
DIST60	0.078	-0.129	0.063	-0.078
DIST70	0.084	-0.128	0.056	-0.080
DIST80	0.038	-0.124	0.088	-0.038
DIST90	-0.118	-0.142	0.215	0.078
DIST99	-0.113	-0.046	0.199	0.044

---

Table 4.10

First order partial correlation coefficients showing the strength of relationship between the number of people in each socio-economic category and the percentage of total capacity available from increasing numbers of nearest surgeries - controlling for total population.

	<u>SEC1</u>	<u>SEC2</u>	<u>SEC3</u>	<u>SEC4</u>
CAP10	-0.059	-0.097	0.090	0.033
CAP20	-0.038	-0.075	0.101	0.013
CAP30	0.018	-0.083	0.085	0.016
CAP40	0.104	-0.036	0.085	-0.071
CAP50	0.151	0.013	0.057	-0.102
CAP60	0.090	-0.035	0.073	-0.002
CAP70	0.017	0.035	0.029	0.048
CAP80	-0.080	-0.010	0.099	0.079
CAP90	0.050	0.085	-0.045	-0.072

---

- 70 ) is considered the main feature is the distinction between the positive correlations for SEC 1 and the negative values for SEC's 3 and 4. Areas with high percentages in SEC 1 are favoured, in contrast to those where percentages in SEC's 3 and 4 are high, by having large amounts of capacity available to them.

From no matter which cell one cares to choose most surgeries of these

ranks will be located in and around the city centre. It is almost as though dentists with large surgeries have tried to maximise their accessibility to demand by locating in the city centre, on those sides of the centre facing "middle class" residential areas, from where it is generally believed most demand for dental care emanates. Alternatively, surgeries located at these points, for other reasons, may have prospered fortuitously, simply because they face relatively large amounts of demand. Whatever the reason, this distribution of surgery capacity supports the point made earlier that the capacities of central surgeries facing owner-occupied sectors of the suburbs tends to be relatively large.

Table 4.11

Correlation coefficients showing the strength of relationship between the percent of population in each socio-economic category in each cell and the capacity available to each cell from increasing numbers of nearest surgeries.

	<u>%SEC1</u>	<u>%SEC2</u>	<u>%SEC3</u>	<u>%SEC4</u>
CAP10	-0.015	-0.078	0.070	-0.037
CAP20	0.046	-0.035	0.005	-0.105
CAP30	0.122	-0.085	-0.034	-0.144
CAP40	0.272	-0.011	-0.143	-0.275
CAP50	0.337	0.027	-0.180	-0.275
CAP60	0.305	0.023	-0.153	-0.200
CAP70	0.149	0.023	-0.132	-0.091
CAP80	0.016	0.011	-0.007	-0.007
CAP90	0.131	0.071	-0.134	-0.157

In conclusion, this analysis of the relationship between

SEC and the supply of dental care has shown that:

- a) in terms of distance, people in SEC's 1 and 2 are favoured relative to those in SEC's 3 and 4;
- b) areas with relatively large percentages in SEC 1 appear to be favoured in terms of the capacity available to them in central surgeries, whereas the reverse is the case for areas with high



percentages in SEC's 3 and 4.

Thus it would seem that the distribution of people in each SEC is associated with the distribution of surgeries and that the socio-economic characteristics of an area are related in some way to the amount of capacity available to it. Whilst it is not possible to thoroughly explain these relationships, it is clear that they will have important effects on the way dental care is used by the population. Because a distribution of surgeries automatically distributes costs and benefits in terms of travel costs and time, SEC's 3 and 4 have to pay a relatively higher cost to make use of dental care facilities in Edinburgh than do SEC's 1 and 2.

### Conclusion

The discussion has considered the distribution of dental surgeries and surgery capacity in Edinburgh. From this, implications have been derived on the spatial availability of dental care within the city. It has been found that central areas faced the shortest distances to, and smallest amounts of capacity from, any given number of nearest surgeries. The reverse situation applied in the suburbs. Finally, the distribution of available care was related to different sub-groups of the population. The conclusion for this part of the analysis is that surgeries are 'attracted' to areas of high population density, to areas with large numbers of people in SEC's 1 and 2, and to areas which do not have much council housing. Capacity was found to be weakly associated with areas where there are large percentages of people in SEC 1 and, at the local level, with council housing areas. Thus, the relationship between the distribution of SEC and that of

dentists, observed at the regional level, also holds at the intra-urban scale within Edinburgh. This may be partly accounted for by the spatial structure of housing tenure and by the business considerations of running a dental surgery. The question of whether this has similar implications for dental health as it has at the regional scale will be examined (through an analysis of the spatial pattern of use) in later chapters.

Note 1.

Levels of significance are not given for tables in this chapter because the analysis concerns two complete populations - surgeries and the residential population of Edinburgh. Therefore, the correlation coefficients are not subject to sampling error and thus do not require levels of significance. However, it is still necessary to make a distinction between correlations worthy of attention and those that are not. Somewhat arbitrarily a correlation coefficient of 0.1 has been selected for this purpose, correlations equal to or greater than 0.1 being taken to merit consideration. A correlation coefficient of 0.1 indicates that variation in one variable accounts for one per cent of the variation in the other. Thus by setting the level of distinction at 0.1 only those relationships where at least one per cent of the variation can be statistically accounted for are selected. To aid the exposition, correlations such as this are termed 'non-zero'.

## Chapter Five

### Dental patients in Edinburgh

The purpose of this chapter is to describe dental patients; to identify their general characteristics and to partly account for their behaviour. As such, this chapter describes the socio-economic background to the analyses of behaviour in subsequent chapters. First the socio-demographic characteristics of dental patients are established and compared with the population, to identify those socio-demographic variables associated with the use of dental care. Then, attendance behaviour and dental status are examined to explain the differential rates of use between different groups. Finally, the spatial distribution of dental patients is correlated with the population's socio-demographic structure to discover its 'association' with the latter.

#### Socio-demographic characteristics

From SDEB and questionnaire data it is plain that dental patients differ from the general population in terms of their socio-demographic characteristics (Tables 5.1 - 5.3). There are relatively more female patients than would be expected given the sex distribution of the population. This suggests that, because they have a higher propensity to attend their dentist, females take greater care of their teeth than do males. Possibly because of their biological make-up females need more dental care. For example, during and immediately following a pregnancy females are more prone to dental problems (this is the main reason that they receive free dental treatment during this period).

Similarly, the SEC structure of dental patients shows a significant divergence from that of the population (Table 5.2). People in SEC's 1

Table 5.1

The distribution of dental patients between the sexes, as estimated by both samples, and a comparison with the population.

	<u>SDEB</u>	<u>POP</u>
Male	(42.7%)	(46.5%)
Female	(57.3%)	(53.5%)
Std.error	0.74%	

Confidence Intervals:

99% Male	40.8% - 44.6%
99% Female	55.4% - 59.2%

---

and 2 are more likely to be dental patients than those in SEC's 3 and 4. The proportions of SEC 1 and 2 in the population are relatively small, whereas they constitute the majority of dental patients. This indicates that SEC may be strongly related to rates of use of dental care.

Table 5.2

The distribution of dental patients across the socio-economic classes, and a comparison with the population.

	<u>Questionnaire</u>	<u>Population</u>
SEC.1	23.2% S.E. = 1.0%	19.3% S.E. = 0.2%
SEC.2	32.9% S.E. = 1.1%	20.6% S.E. = 0.6%
SEC.3	14.8% S.E. = 0.8%	28.3% S.E. = 0.2%
SEC.4	10.9% S.E. = 0.7%	22.9% S.E. = 0.2%

99% Confidence intervals

SEC.1	20.6% - 25.8%	18.8% - 19.8%
SEC.2	30.1% - 35.8%	20.1% - 21.1%
SEC.3	12.7% - 16.9%	27.8% - 28.8%
SEC.4	9.1% - 12.7%	22.4% - 23.4%

Standard errors have been calculated for the census figures because they are drawn from the 10 per cent sample and therefore are also estimates, and thus require confidence intervals to be placed around them.

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Only one age-group forms the same proportion of both the population

and dental patients, those aged 35 to 44 (Table 5.3). In terms of their rate of use patients in the age-group four and under are under-represented relative to their share of the population. Age-groups over four are progressively more over-represented, to a peak for those aged 21 to 34. Subsequently, representation falls and from 45 onwards there is increasing under-representation. Hence, people aged 5 to 34 are more likely to be dental patients than people younger or older than this. The majority of patients are younger than 35 whereas the larger part of the population is 35 or over.

Table 5.3

The age-group distribution of dental patients, from the SDEB sample, and a comparison with the population.

<u>Age</u>	<u>SDEB</u>	<u>99% Confidence interval</u>	<u>POP</u>
0 to 4	4.6% S.E. = 0.3	3.8% - 5.4%	7.1%
5 to 10	12.7% S.E. = 0.5	11.4% - 14.0%	9.2%
11 to 15	11.0% S.E. = 0.5	9.7% - 12.3%	7.3%
16 to 20	14.6% S.E. = 0.5	13.3% - 16.0%	8.0%
21 to 34	25.6% S.E. = 0.7	23.8% - 27.4%	18.3%
35 to 44	11.0% S.E.= 0.5	9.7% - 12.3%	11.0%
45 to 54	9.6% S.E.= 0.4	8.6% - 10.6%	12.0%
55 to 64	6.1% S.E.= 0.4	5.1% - 7.1%	12.7%
65 plus.	4.6% S.E.= 0.3	3.8% - 5.4%	14.4%

Thus dental patients differ from the general population in their age, sex and SEC characteristics. To better understand these differential rates of use the probability, for each sub-group, of being a dental patient is presented. This is followed by a survey of the literature concerned with 'why' people use dental facilities and why there is variation between groups.

In the SDEB sample the total number of patients who lived in Edinburgh was 4413. However, only 4291 of these can be ascribed to

residential areas which existed at the time of the 1971 census. As it is the total population of Edinburgh in 1971 which forms the basis on which individual probabilities are calculated it is the latter total of patients that is used in calculations, to ensure the probabilities are as accurate as possible.

The SDEB sample was a 25 per cent sample, implying that approximately 17,164 of the estimated total of 20,768 dental returns made during the month of September, 1977, were for patients from Edinburgh. Given that the total population of Edinburgh is approximately 453,125 (1971 census), the probability of an Edinburgh resident being a dental patient during that month, therefore, is 3.8 per cent. Whether this proportion is constant or variable is not known, though there is no reason to suspect the latter.

However, it is most unlikely that, from a random sample of the population 3.8 per cent would be dental patients. The question is to what extent do the factors of age, sex and SEC influence the probability of being a dental patient?

To answer this question sub-group probabilities were derived on the basis of sample estimates. Tables 5.1 - 5.3 show the percentage age, sex and SEC distributions for the resident population and for dental patients. These percentages can be turned into absolute numbers, showing the total population and estimated number of patients in each category, by applying them to the population total of 453,125 and the SDEB sample estimate of 17,164. From these figures it is an easy step to calculate the probability of a member of the public in any



category being a dental patient (Table 5.4).

The probabilities shown in Table 5.4 are, essentially, measures of the rate at which each age group uses NHS dental care services. For every hundred people in each group the percentage probability shows the proportion of people who would actually use dental care services during a given month. It can be seen that there is considerable variation in these probabilities, the greatest variation being between age-group 16-21, with a probability of 6.9%, and age group 65+, with a probability of 1.2%.

Table 5.4

The probability of being a patient for different population sub-groups.

Pr. = (No. of Patients / Pop) x 100

<u>SEX</u>	<u>MALE</u>	<u>FEMALE</u>			
Pr.	3.6%	4.2%			
<u>SEC</u>	<u>SEC1</u>	<u>SEC2</u>	<u>SEC3</u>	<u>SEC4</u>	
pr.	4.7%	6.3%	2.0%	1.9%	
<u>AGE-GROUPS</u>					
	<u>0-4</u>	<u>5-10</u>	<u>11-15</u>	<u>16-20</u>	<u>21-34</u>
Pr.	2.5%	5.2%	5.7%	6.9%	5.3%
	<u>35-44</u>	<u>45-54</u>	<u>55-64</u>	<u>65+</u>	
Pr.	3.8%	3.0%	1.8%	1.2%	

The extent of under and over representation reflects the degree to which each sub-group demands dental care. It is appropriate at this point to review the literature concerned with who uses dental care and why they use it. Firstly, to compare the findings of this study about 'who' uses dental care with those of previous works. And, secondly, to gain some understanding of 'why' people do use dental care services, and thus, why there are variable rates of use between

groups.

In general, studies of why people use dental care services have concentrated on the beliefs and motivations of individuals, sometimes set within the context of personal circumstances. These works have also made the distinction between preventive visits to the dentist and those that are symptomatic, i.e. resulting from toothache. The overwhelming concentration of interest has been on preventive visits. Using the terminology of Mechanic (1962), writers have concentrated upon "health behaviour", that is, behaviour by a healthy person for the purpose of preventing or detecting future bouts of disease. "Illness behaviour", for example, where a person attends a dentist because he has toothache, has tended to be ignored. Thus, these studies have tried to show combinations of beliefs, motivations and circumstances which are conducive to making preventive dental visits.

The most prevalent notions about why people make preventive dental visits concern the inter-relations between a person's belief in his susceptibility to dental disease and his belief in the efficacy of taking preventive action. In a series of papers, Kegeles (1961, 1963a and 1963b) has argued that for a person to take preventive action he must believe:

- a) that he is susceptible to a particular dental problem;
- b) that being affected by the problem would be serious for him;
- c) and that he could take pre-<sup>P</sup>emptive action to prevent or alleviate the problem.

In addition, he postulated that 'barrier' variables would inhibit

preventive behaviour. Thus

- a) the fear of pain may encourage a person to delay visiting his dentist until actual pain overcomes his fear;
- b) anxiety about the type of treatment he may receive;
- c) or a negative image of dentists generally may discourage him from making use of preventive dental services.

However, it is unlikely that dental disease will generally be regarded as serious; it is not a killer (Butler, 1967).

Antonovsky and Kats (1970) also include these concepts in their study, though their conception is somewhat broader. They considered three types of variable:

- 1) motivating or goal-achieving variables;
  - a) enhancement of health or avoidance of ill health;
  - b) achievement of approval by significant others;
  - c) achievement of self-approval;
- 2) blocking variables;
  - a) knowledge, or lack of it, of how to take preventive action;
  - b) anxiety or fear of pain;
  - c) availability of resources, e.g. time, money practitioners, etc.;
- 3) conditioning variables;
  - a) belief in susceptibility;
  - b) education (has effect on knowledge);
  - c) effect of previous experiences;
  - d) socio-economic status (low status may reinforce effect of time and cost blocks).

They argued that "... it is the combination of effective motivation and blockage variables which predict ... preventive health behaviour. These, in turn, are explicable by reference to the conditioning variables."

These works by Kegeles and Antonovsky and Kats are the only 'theoretical' approaches which have attempted to answer the question of 'why' people use dental services. Though the substantive work supporting them appears to validate the concepts used, their predictive ability was recognised by both to be weak. Indeed, Kegeles (1963b) recognised that previous behaviour and socio-economic status are much better predictors of who will make preventive dental visits.

In fact, the strong relationship between rates of use of dental services and socio-economic status is well known in the literature. In the USA annual income, occupation status and length of education have all been correlated with the use of dental services (Friedson and Feldman, 1958; Kegeles, 1963a and 1963b; Kreisberg, 1963; Haefner, Kegeles, Lirscht and Rosenstock, 1967; Nikias, 1968). As income, occupational status and length of education decline, so also do rates of use of dental services (i.e. the making of preventive dental visits). In addition, the same authors have shown that, beyond early adulthood, rates of use decline with age, and that females are likely to make more use of dental services than males. However, Nikias notes that the rate of use does not decline with age amongst people of high social status, whereas it does amongst those of low social status. It appears that people of high social status retain

their teeth into old age and therefore require continued treatment. In Britain the same relationships have also been found (Beal and James, 1970; Beal and Dickson, 1974; Todd and Whitworth, 1974). Assuming that SEC is a surrogate for income, education and occupation, the findings of this study concur with these earlier works. High status being associated with high rates of use and low status with low rates of use (Table 5.4).

However, it should not necessarily be assumed that the relationship between socio-economic status and behaviour is cultural, i.e. deriving from the influence of a person's parents. It has been argued by Kriesberg (1963) that this relationship may be cultural, or that it may be situational. This latter type of behaviour can result from social conditions, for example, patterns of interaction, or from non-social conditions, for example, variations in financial resources. Thus his argument is that apparent differences between cultural groups may not be caused by cultural differences but by the different situations faced by different groups.

For example, it has been shown that the percentage of people believing that they should attend a dentist regularly, to maintain their dental health, declines as socio-economic status declines (Freidson and Feldman, 1958). Kriesberg would argue that because people of lower socio-economic rank are more likely to mix together, their beliefs will reflect the shared experience of people in the same situation. They are more likely to know people who have lost their teeth than are people in higher ranks and therefore they may believe that teeth cannot be maintained and that it is not worthwhile

trying to do so (Kriesberg, 1963). Hence, people's beliefs may result from the experience of others with whom they mix.

Of course, situational factors may be of an enhancing or blocking nature and are thus somewhat akin to Antonovsky and Kats' blocking and conditioning variables. Similarly, the cultural factors are closely related to their "motivating" variables. The discussion will now turn to a consideration of some of the factors included in the above 'theoretical' formulations. Following Kegeles, variables will be considered under the headings of motivations and barriers.

### Motivations

With regard to motivations, Kegeles (1963a and 1963b) found that people who believed in their susceptibility to dental disease were more likely to make preventive dental visits than those who did not. In a previous paper, Kegeles (1961) had asserted that most people have adequate reason for feeling susceptible to dental disease either from their own experiences or those of people they know. This was based on earlier works he had reviewed which indicated that very few people had never been to a dentist.

Yet, not everybody does feel susceptible. It has been shown in America that about 27 per cent of those who do not see a dentist regularly felt their teeth were alright and that there was no need to go (Freidson and Feldman, 1958). Similarly, in this country a study of the dental needs of the elderly found that "insufficient need" was a common response to a question about why elderly people do not attend a dentist (Gould, 1978). People giving this response were

also associated with low levels of worry about their dental status. It has been suggested by Butler (1967) that "... differential perception of what constitutes ill health " may be a reason for people not using dental care services. Dental caries is one of the most prevalent diseases in the population, but it may have a "... negative illness-acceptance component" (Butler, 1967), that is, people who do not believe in their susceptibility to dental disease simply do not perceive their illness or are prepared to accept lower standards of dental health before recognising ill-health (Nikias, 1968).

Thus it would appear that a belief in one's susceptibility to dental disease does encourage one to make preventive dental visits. The lack of such a belief seems to be associated with groups of people who are less likely to take preventive action and less concerned about the consequences.

Obviously, it is a pre-requisite for taking preventive action that people know what action to take and believe that such action will be beneficial (Kegeles, 1961; Antonovsky and Kats, 1970). It was demonstrated by Freidson and Feldman (1958) that 88 per cent of respondents knew that regular visits were important in the maintenance of dental health. Nevertheless the proportion of the population who attend a dentist regularly has been estimated by Kegeles (1961) to be between 15 - 20 per cent and by Todd and Whitworth (1974) to be 33 per cent. Therefore, there is a wide discrepancy between knowledge and actual behaviour.

Evidence that belief in 'regular attendance' declines with socio-economic status has already been alluded to (Freidson and Feldman, 1958). The same study also showed that this belief was held by more women than men and that the extent of its acceptance declined with age. Hence, those groups that this study has shown to have lower propensity to attend a dentist may not believe in the value of regular visits. People who believe dental disease cannot be prevented (i.e. a fatalistic belief) are less likely to make preventive visits than people who believe in natural causation (Kegeles 1963a and 1963b).

Aesthetic motivations have also been considered in the literature (Kegeles 1963a and 1963b; Shuval, 1971). Kegeles showed that people who were concerned about the appearance of their teeth were more likely to make preventive dental visits than those who were not. Parents who were concerned about their children's teeth were much more likely to make preventive visits than those who were not. On the other hand, Shuval showed that Israelis were very little concerned about the aesthetic appearance of their teeth, perhaps for cultural reasons.

Accordingly, it does appear that belief in one's susceptibility to dental disease, in the requirement for regular visits to a dentist, in natural causation, and in the aesthetic value of good dental health are associated with actual behaviour. Therefore, it is possible that these beliefs are held more extensively by those groups which this study has found to make above average use of dental care facilities than those who do not.



## Barriers

Traditionally, the major barrier to dental care has been its cost. Often this relationship is implied by figures relating rates of use to income (Freidson and Feldman, 1958; Kegles, 1963a and 1963b; Haefner et al, 1967; Nikas, 1968; Antonovsky and Kats, 1970). Intuitively, it seems reasonable that those with small incomes will be less able to pay for dental care than those with large incomes. However, Kegeles' (1963a and 1963b) survey was undertaken on a population to whom dental care was provided free by their employer, the Endicott-Johnson Corporation. Clearly, in this case cost could not be a barrier, yet the same relationship between income and rates of use was found. In similar circumstances Nikias (1968) obtained the same result. Perhaps, therefore, cost is not the barrier it has appeared to be. It was shown by Freidson and Feldman (1958) in their national survey, that only fourteen per cent of those not attending a dentist regularly gave cost as the reason. On the other hand, they did show that 34 per cent of those who felt they should have had more care during the previous year, gave cost as the reason for not getting it.

Leverett and Jong (1967) have shown that demand for dental care in Boston increased after the introduction of the Medicaid Program in Massachusetts. Medicaid is designed to make medical care more available to the poor, in the USA by removing the burden of cost. This rise in demand would indicate that, in America, cost has been a significant factor in inhibiting demand for preventive dental care, especially amongst the poor.

In this country, though costs have been largely subsidised though the NHS, charges are still made and are therefore likely to exert an influence. Gould (1978) showed that, for the elderly this is the case. She noted that the major reason for elderly people not attending a dentist was cost. However it must be pointed out that the majority had no idea what the cost of treatment was likely to be. One interpretation is that the financial resources of the elderly are fully stretched without the additional burden of paying for dental care.

Hence, on balance, the evidence suggests that cost is a deterrent to the use of dental care services. However, this evidence is not conclusive and does not provide comprehensive coverage of population sub-groups. Thus, before more substantial conclusions can be drawn much more detailed survey work and analysis is required.

A person's opinion of the dentist himself may also influence preventive dental behaviour. It was shown in the USA (Freidson and Feldman, 1958) that the prestige of dentists is very high, being rated above that of the pharmacist, lawyer and school teacher and below only the physician. Nevertheless, Kegeles (1961), after reviewing literature from the field of psychiatry concluded that there was evidence to show that fear of the dentist does exist and that people with certain personality structures suffer more dental disease, perhaps because those who fear the dentist do not attend regularly and therefore tend to have more dental disease.

Intuitively, it might seem to be a person's previous experience of

dental care which underlies current behaviour. Nonetheless, little work has concentrated on this area. People who make preventive dental visits were shown by Kriesberg (1963) to have a high probability of having made their first dental visit when they were very young. However he argues that it is not knowledge or values that are transmitted from one generation to the next, but simply the habit of going to the dentist. A similar relationship between age at first attendance and subsequent attendance behaviour has been found by Nikias (1968) and Shuval (1971). In Britain it was shown that mothers in social classes I and II are most likely to favour making their child's first visit to the dentist before the child is three years old (Beal and Dickson, 1974). The percentage holding this view declines with social class. Therefore it would appear that 'middle class' parents are most likely to train their children into good "dental behaviour", i.e. to make good use of dental care facilities. It may also be that lower class parents accept lower standards of dental health before recognising and acting upon, ill-health, that is, they may not recognise that dental caries is <sup>s</sup>incidious, and only perceive 'ill-health' when the damage has been done.

Another aspect of previous experience has been reported on by Freidson and Feldman (1958). They found that 89 per cent of those respondents who had attended a dentist during the previous year were 'entirely satisfied' with their treatment. Furthermore, 82 per cent had not had a 'bad' previous experience of receiving dental care. On the other hand, of those that had had such an experience the majority displayed lower rates of dental attendance.

Hence it appears that the most important previous experience is a person's training, vis-a-vis attendance behaviour, by his parents. That such a large proportion of Freidson and Feldman's sample were entirely satisfied would seem to belie the common popularity of 'fear of pain' as a reason for not attending a dentist regularly. Nevertheless, the fact that some of their respondents had had negative experiences with dentists is evidence of some people having a 'fear of pain'. That such a fear does influence the number of people making preventive dental visits has been shown by Kegeles (1963a and 1963b) and Shuval (1971).

Whether the barrier effects of these variables partly explains the variable rate of use identified by this study cannot be determined. However, they are part of the only 'explanation' which currently exists, and therefore, in the absence of alternative theories, it may be assumed that they do.

It is clear that explanations based on geographic space have not been considered very much. Although such considerations do appear in the literature they tend to be descriptive or speculative rather than explanatory. For example, Kegeles (1963a and 1963b) showed that respondents living more than ten miles from a city with a dental clinic made fewer preventive visits than did those living less than this distance from care. The implication is that distance is a barrier. Within an urban environment it was shown that different population sub-groups travel different distances for dental care (Leverett and Jong, 1967). In Boston blacks travelled an average of 1.67 miles compared with 0.94 miles for whites. Many more blacks used

public transport than whites and the per capita cost was 50 per cent greater than for whites, probably because of the distances involved. This suggests that space may be of more significance to the behaviour of some groups than to others.

Finally, Freidson and Feldman (1958) concluded that, on the basis of respondents' replies, distance was not a very important reason for not attending a dentist regularly. Nevertheless, they do speculate that distance may be more important for the working man than for his wife, mainly on the grounds that the former has not got the time to travel long distances, especially if time means money.

#### Attendance behaviour and socio-demographic characteristics

Further understanding of the variable rates of use demonstrated in this study may be obtained by considering the relationship between attendance behaviour and socio-demographic characteristics. More particularly, it was expected, given the previous discussion, that those groups which are over represented would contain more people taking preventive action (i.e. being regular attenders) than the groups which are under represented. In addition, implications for the dental health of patients with different types of attendance behaviour are discussed.

This examination of attendance behaviour is concerned with the frequency of attendance. The attendance behaviour of Scottish adults from the general population has been examined by Todd and Whitworth (1974). They found that only 33 per cent of Scottish adults attended for regular check-ups compared with 53 per cent who attended only

when having trouble with their teeth. The remaining 14 per cent attended occasionally for check-ups. It seems reasonable to suppose that people designating themselves as 'occasional' attenders feel themselves to be susceptible to dental disease and recognise the importance of attending a dentist in order to maintain their dental health. At the same time, these people appear not to recognise the importance of 'regular' visits. If regular attendance is associated with good dental health (Todd and Whitworth) then clearly the bulk of Scottish adults are making inadequate use of dental facilities.

In this study the attendance behaviour of patients is considered. One would expect that at any one time the majority of patients would be regular attenders, with patients who attend 'occasionally' or only when 'having trouble' forming the minority. This is indeed the case. Regular attenders formed a large majority (58%), compared with occasional attenders (19%) and those who attend only when having trouble (21%) (Table 5.5). This is supported by a cross-tabulation of 'type of attender' by the number of other courses of treatment received during the previous two years (Table 5.6). Forty four per cent of regular attenders had had three or four other courses of treatment compared to only 4 per cent of patients attending only because they were having trouble.

With the decline in rate of use beyond the 16 to 20 age-group (Table 5.4) it might be expected that decreasing proportions of each subsequent age-group would be regular attenders whilst increasing proportions would be occasional or 'only when having trouble' attenders, especially the latter. This is indeed the case (Table 5.7)



Table 5.5

The percentage of questionnaire respondents who claimed to attend regularly, occasionally and only when having trouble.

Regular attenders	58.1%
Occasional attenders	18.7%
Only when having trouble	21.0%

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Table 5.6

The percentage of each type of attender who had had 1, 2, 3 or 4 other courses of treatment during the previous two years.

<u>Other courses of treatment</u>	<u>Regular</u>	<u>Occasional</u>	<u>Trouble</u>
1	12.7%	28.1%	20.6%
2	19.1%	17.8%	10.2%
3	23.8%	7.9%	2.9%
4	20.2%	2.3%	1.3%

---

Whilst the largest proportion of all age-groups are regular attenders, there is a decline in the size of this proportion from age 35 onwards. In addition, of those aged 21 and over, patients who do not attend regularly are most likely to attend only when having trouble.

With regard to the sexes, and the fact that females have the greater propensity to be dental patients, it is not surprising to find a larger proportion of females are also regular attenders. Conversely, a larger proportion of males attend only when having trouble.

Finally, a similar situation exists for SEC. Larger proportions of SECs 1 and 2 are regular attenders than is the case for SECs 3 and 4. Indeed, regular attenders form the majority in SECs 1 and 2 but not

in SECs 3 and 4. Compared with SECs 1 and 2, larger proportions of

Table 5.7

The pattern of attendance for questionnaire respondents in each age-group, sex and SEC.

	<u>Regular</u>	<u>Occasional</u>	<u>Trouble</u>
<u>Age-groups</u>			
0-4	42.9%	0.0%	14.3%
5-10	69.9%	17.8%	11.0%
11-15	63.8%	18.1%	16.0%
16-20	51.0%	25.9%	22.6%
21-34	58.0%	20.1%	20.8%
35-44	66.3%	13.9%	17.6%
45-54	60.2%	18.0%	18.0%
55-64	53.1%	15.4%	29.9%
65+	44.0%	13.8%	34.5%
<u>SEX</u>			
Males	51.3%	21.4%	24.3%
Females	62.5%	17.1%	18.8%
<u>Socio-economic Category</u>			
SEC1	69.3%	17.7%	12.3%
SEC2	66.9%	15.5%	16.6%
SEC3	49.3%	23.3%	26.3%
SEC4	38.2%	22.6%	35.2%

SECs 3 and 4 attend only when having trouble. Furthermore, in SECs 3 and 4 the proportion of 'having trouble' attenders is larger than those of 'occasional' attenders, whereas in SEC 1 the reverse is true.

Thus, the pattern of attendance is associated with the different rates of use of the various sub-groups. Those groups having high rates of use have large proportions of 'regular' attenders compared with groups with low rates of use. Patients who attend only when having trouble are proportionately greater in the groups with low rates of use. 'Occasional' attenders appear to be associated with groups that have high rates of use. Taken together, it appears that the pattern of attendance, at least partly, 'accounts for' the variation in rates of use. That is, those groups who attend regularly



naturally record higher levels of use.

It is beyond the scope of this study to test this hypothesis, because the data here pertains to the population of patients rather than to the population generally. Nonetheless, Todd and Whitworth (1974) have evidence which supports this argument (Table 5.8). They showed that the proportion of the population who are regular attenders increases with social status, is more prevalent amongst females than males and increases from age 16 to age 34, beyond which it declines. The proportion of the population who attend only when having trouble increases with age, is greater amongst the males than females and increases with decreasing social status. These patterns correspond very closely to the picture drawn by this study, concerning patients, and lends weight to the above hypothesis.

At this point it is of interest to examine the relationship between pattern of attendance and dental status, to see what happens when people do not make regular use of dental care facilities. A direct examination of the relationship between pattern of attendance and dental status cannot be undertaken because these variables come from two different sources and consequently cannot be cross-tabulated. However, it is possible to disaggregate both sources to the half kilometre square grid and correlate them across the cells. Disaggregation enlarges the standard error, however, by reducing the average sample size per areal unit, and therefore makes the results less decisive.

When this analysis was carried out only one statistically significant

Table 5.8

The pattern of attendance for each age-group, sex and social class categories of the Scottish adult population (with some natural teeth). Source: Todd and Whitworth, 1974.

	<u>Regular</u>	<u>Occasional</u>	<u>Trouble</u>	(base) (numbers)
<u>Age-groups</u>				
16-24	33%	17%	50%	382
25-34	34%	15%	51%	297
35-44	36%	9%	55%	234
45-54	33%	10%	57%	152
55 and over	29%	10%	61%	105
<u>Sex</u>				
Males	27%	12%	61%	601
Females	40%	15%	45%	569
<u>Social class</u>				
I, II and III non-manual	51%	14%	35%	367
II manual	26%	13%	61%	470
IV non-manual				
IV manual and V	20%	12%	68%	255
Total%	33%	14%	53%	(1170)

relationship was found, a negative correlation between the mean number of missing teeth for patients in each cell and the percentage of patients who are occasional attenders (Table 5.9). This is rather difficult to interpret because it is an isolated result. But it suggests that occasional attenders do not attend frequently enough to have had a large number of teeth extracted.

Despite the weakness of these correlations a basic indication of the relationship between dental health and pattern of attendance can be obtained from examination of the signs of the coefficients. The negative relationships between regular attendance and fillings and extractions suggest that regular attenders require only limited treatment when they present themselves for treatment. On the other

hand, those who attend occasionally or only when having trouble have a slight tendency to require more treatment, as indicated by the positive correlations.

Table 5.9

The direction of the relationships between dental status and pattern of attendance.

	Dental Status		
	<u>Missing</u>	<u>Filled</u>	<u>Extracted</u>
Regular	.022	-.082	-.066
Occasional	-.102*	.085	.046
Having trouble	.042	.065	.066

\* - SIGNIFICANT AT THE .05 LEVEL

Missing: Number of teeth missing at start of course of treatment.  
 Extracted: Number of teeth extracted during course of treatment.

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However, regular attenders and those who attend only when having trouble are both positively associated with missing teeth, whereas occasional attenders are not. At first glance this may appear surprising, but Todd and Whitworth have shown that people who attend only when having trouble have a strong preference for the extraction of an aching tooth, especially if it is a back tooth. Regular attenders, it would seem, attend frequently enough to have had relatively large numbers of teeth extracted.

This interpretation is only tentative, because of the weak correlations. Nevertheless, the data do provide some evidence to show that dental status is associated with pattern of attendance.

#### Socio-demographic characteristics and the distribution of patients

The final part of this analysis is concerned with determining the

relationship between socio-demographic factors and the spatial distribution of patients. Figure 5.1 shows the percentage of each cell's population who were identified as dental patients by the SDEB sample. Clearly there is considerable variation between cells. The question is, how much of that variation can be 'accounted for' by age, sex, and SEC?

Correlations between the 'percentage patients' in each cell and the percent of the population in each sex, SEC and age-group show that the strongest correlations occur with the SEC variables (Table 5.10). The 'percentage patients' in each cell varies with the percentage of females and the percentage in SEC 1, and inversely with the percentage of males and the percentage in age-group 11 to 15 and SECs 3 and 4. Generally, this pattern would be expected given the foregoing discussion on rates of use. However, somewhat surprisingly, only two of the age-groups have significant relationships with 'percent patients', and one is in the opposite direction to what might have been expected. It was shown earlier that patients were significantly different from the population in eight of the nine age-groups, and those aged 11 to 15 were over represented when compared with the population. Thus, a positive correlation for this age-group might have been expected.

Because SEC has the strongest correlation with the 'percentage patients', these variables in a statistical sense 'explain' the largest proportion of variation in 'percentage patients'. However, not all the significant variables may make a contribution to the overall level of explanation because of co-variation between the

Figure 5.1 The percentage of population in each cell who were identified as dental patients by the SDEB sample

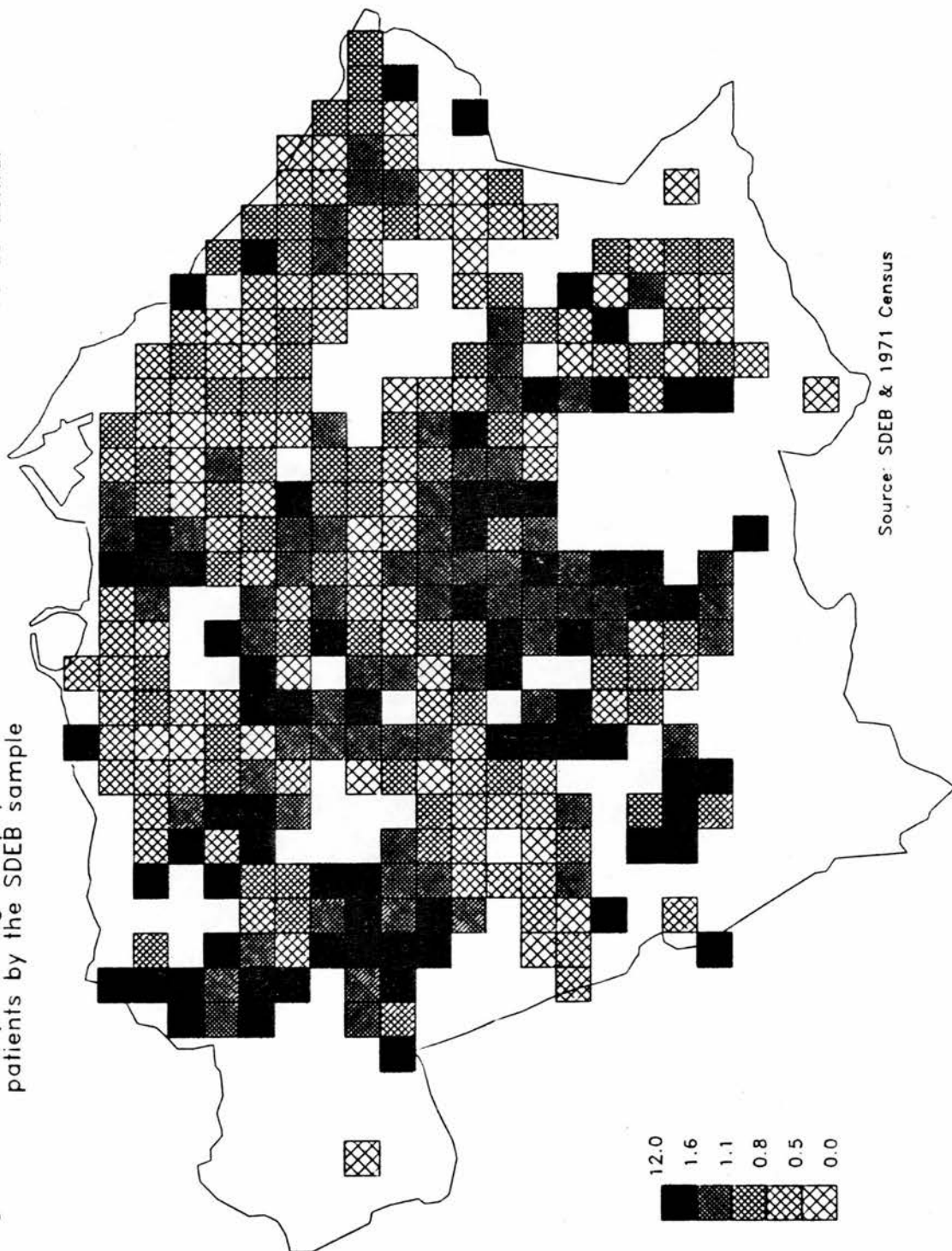


Table 5.10

The strength of association between the proportion of dental patients in each cell and the proportion in each sex, SEC and age-group.

Percent population			<u>Percent patients</u>
male			-.183
"	"	female	.183
"	"	in SEC1	.354**
"	"	" " 2	.076
"	"	" " 3	-.257**
"	"	" " 4	-.383**
"	"	aged 0-5	.050
"	"	" 5-11	.029
"	"	" 11-16	-.136**
"	"	" 16-21	-.128**
"	"	" 21-35	-.027
"	"	" 35-45	.036
"	"	" 45-55	-.027
"	"	" 55-65	-.038
"	"	" 65+	.193

\*\* = .01 level of significance

\* = .05 level of significance

---

variables. For example, the percentage male and female in each cell will be perfectly correlated with one another. This is because they are measured in percentages and one is the perfect complement of the other. Therefore, the information of one is subsumed within the other.

To take account of the co-variation, and so overcome this problem, partial and multiple correlation techniques were employed (Tables 5.11 - 5.15). In multi-variate analysis the order in which variables are entered into a correlation analysis can sometimes have theoretical significance. However, in this instance that is not the case, the variables are entered into the analysis on the basis of statistical 'significance', the most significant first. Entry stops when the next most significant variable would produce an increase in the total level of explanation of less than 0.01 or 1 per cent.

Entering the variables in this way has a useful side effect. Because the demographic variables are presented as proportions, they sum to unity. That is, for any cell, all the age-group variables will sum to 100 per cent; as will all the SEC and sex variables. Therefore, if all the age-group variables, say, were included in the analysis a certain amount of statistical redundancy would occur. To avoid this problem, known as 'closure', one of the variables should be omitted. The question is which variable.

A stepwise model with a minimum level of acceptance obviates this problem, because this approach incorporates co-variation into its calculations and because only the variation that is unique to a variable (i.e. over and above co-variation) is used as the criteria for inclusion. This means, firstly, that not all the variables are included, because some are redundant and, secondly, the variables that are included are those with the most 'explanatory' power.

The proportion of males in the population accounts for 3.4 per cent of the spatial variation in the 'per cent patients' (Table 5.11). Whilst this may be statistically significant, it is plainly of little practical importance in terms of explanatory power. If the proportion of females had been used instead an equal amount of 'explanation' would have been achieved.

The age distribution of the population in each cell accounts for 11.7 per cent of the variation in 'percentage patients' (Table 5.12). When the percentage in age-groups 5 to 10 and 65 plus is large and the percentage in age groups 11 to 15 and 55 to 64 is small the

Table 5.11

Multiple and partial correlation coefficients and R squared values for correlations between the proportion of dental patients in each cell and the proportion of males.

$X_0$  - percent patients

$X_1$  - percent male

STEP 1

$R_{0,1} = .183$

$R^2_{0,1} = .034$

---

proportion of dental patients tends to be large. It is these four age-groups that 'account for' 11.7 per cent of the variation in the 'percentage patients', and the direction of their contribution is as suggested by their signs in the previous analysis (Table 5.10). In addition, by partialling out the variables already in the equation the correlations of age-groups 5 to 10 and 55 to 64 are revealed as statistically significant. At the same time, age-group 16 to 20 which was significant earlier (Table 5.10), does not now enter the equation at all. This uncovering and repression of significance indicates the colinearity between the age-groups.

A rather more substantial amount of explanation can be gleaned from the SEC variables (Table 5.13). More than 17 per cent of the variation in 'percentage patients' can be accounted for by variation in SECs 4 and 1. Though SEC3 is significantly related to 'percent patients' in the bivariate analysis (Table 5.10) it makes no contribution in this multivariate situation. This indicates a degree of co-variation with one or more of the variables included in the analysis, probably SEC 4.

Thus, spatial variation in the 'percentage patients' is best



Table 5.12

Multiple and partial correlation coefficients and R squared values for correlations between the proportion of dental patients in each cell and the proportion in each age-group.

$X_0$ - percent patients	
$X_1$ - " aged 0-4	$X_6$ - percent aged 35-44
$X_2$ - " " 5-10	$X_7$ - " " 45-54
$X_3$ - " " 11-15	$X_8$ - " " 55-64
$X_4$ - " " 16-20	$X_9$ - " " 65+
$X_5$ - " " 21-34	

STEP 1  
 $R_{0,9} = .193 \quad R^2_{0,9} = 0.037$

STEP 2  
 $R_{0.9,8} = .274 \quad R^2_{0.9,8} = 0.075$

STEP 3  
 $R_{0.9,8,2} = .304 \quad R^2_{0.8,8,2} = .093$

STEP 4  
 $R_{0.9,8,2,3} = .342 \quad R^2_{0.9,8,2,3} = .117$

---

Table 5.13

Multiple and partial correlation coefficients and R squared values for correlations between the proportion of patients in each cell and the proportion in each SEC.

$X_0$ - percent patients
$X_1$ - " in S.E.C.1
$X_2$ - " " " 2
$X_3$ - " " " 3
$X_4$ - " " " 4

STEP 1  
 $R_{0,4} = .383 \quad R^2_{0,4} = .147$

STEP 2  
 $R_{0.4,1} = .415 \quad R^2_{0.4,1} = .173$

---

explained by variation in SECs 4 and 1 and age groups 5 to 15 and 55 and over, whilst sex has little explanatory power. To take the analysis one step further, we must now consider whether the level of explanation can be significantly raised by including all three types

of variable at the same time. The overall level of explanation is raised to 24.8 per cent (Table 5.14). Once again partial correlation, by accounting for co-variation has revealed the individual significance of particular variables, hidden in the previous situation. At step 3 the percent aged 35 to 44 is entered, at step 4 the percent aged 65 and over, and at step 5 the percent aged 55 to 64. Age-groups 11 to 15 and 15 to 20, which earlier appeared as significant (Table 5.10) do not appear in the analysis at all.

Clearly other factors are also important. These may relate to mobility and attitudes. To test this, variables concerning car-ownership and education - as surrogates for mobility and attitudes - were also included (Table 5.15). The result is that after four steps the overall level of explanation has been raised to 27 per cent. At step 2 the percentage of households owning two or more cars was entered, suggesting that mobility might be an important factor in deciding whether a person attends a dentist or not. Also, this variable must include much of the 'explanatory power' of SECl, because the latter variable was not entered at all.

### Conclusion

This chapter has shown that dental patients, as a group, differ quite considerably from the population in terms of their socio-demographic characteristics. Females, people aged 5 to 34, and people in SECs 1 and 2 had higher propensities to be dental patients than did other population sub-groups.

Such differences were matched by variations in attendance behaviour.

Table 5.14

Multiple and partial correlation coefficient and R squared values for correlations between the proportion of dental patients in each cell and the proportion in each age-group, sex and SEC, presented together.

X <sub>0</sub> - percent patients	X <sub>8</sub> - percent aged 5-10
X <sub>1</sub> - " male	X <sub>9</sub> - " " 11-15
X <sub>2</sub> - " female	X <sub>10</sub> - " " 16-20
X <sub>3</sub> - " in SEC1	X <sub>11</sub> - " " 21-34
X <sub>4</sub> - " " SEC2	X <sub>12</sub> - " " 35-44
X <sub>5</sub> - " " SEC3	X <sub>13</sub> - " " 45-54
X <sub>6</sub> - " " SEC4	X <sub>14</sub> - " " 55-64
X <sub>7</sub> - " aged 0-4	X <sub>15</sub> - " " 65 +

STEP 1

$$R_{0,6} = .383 \quad R^2_{0,6} = .147$$

STEP 2

$$R_{0,6,3} = .415 \quad R^2_{0,6,3} = .173$$

STEP 3

$$R_{0,6,3,12} = .444 \quad R^2_{0,6,3,12} = .197$$

STEP 4

$$R_{0,6,3,12,15} = .489 \quad R^2_{0,6,3,12,15} = .240$$

STEP 5

$$R_{0,6,3,12,15,14} = .498 \quad R^2_{0,6,3,12,15,14} = .248$$

Regular attendance was most common amongst these same sub-groups.

There was some evidence, though it was weak, to show that

differences in dental health were associated with attendance

behaviour, regular attenders tending to have better dental health.

Variation in propensity to be dental patients between population sub-groups was shown to have a social and geographic component. Up to 27 per cent of the geographic variation in the distribution of patients was associated with socio-demographic attributes of the population. Though this is not insignificant, it still leaves a great deal of variation to be explained.

Table 5.15

Multiple and partial correlation coefficients and R squared values for correlations between the proportion of patients in each cell and the proportion in each category of the sex, SEC, age-group, car-ownership and educational attainment variables.

X <sub>0</sub> - percent patients	X <sub>10</sub> - " " 16-20
X <sub>1</sub> - " male	X <sub>11</sub> - " " 21-34
X <sub>2</sub> - " female	X <sub>12</sub> - " " 35-44
X <sub>3</sub> - " in S.E.C. 1	X <sub>13</sub> - " " 45-54
X <sub>4</sub> - " " " 2	X <sub>14</sub> - " " 55-64
X <sub>5</sub> - " " " 3	X <sub>15</sub> - " " 65+
X <sub>6</sub> - " " " 4	X <sub>16</sub> - " HH with 1 car
X <sub>7</sub> - " aged 0-4	X <sub>17</sub> - " HH with 2 cars +
X <sub>8</sub> - " " 5-10	X <sub>18</sub> - " " A' level
X <sub>9</sub> - " " 11-15	X <sub>19</sub> - " " degree
	X <sub>20</sub> - " " no educn.

STEP 1

$$R_{0,6} = .383 \quad R^2_{0,6} = .147$$

STEP 2

$$R_{0.6,17} = .434 \quad R^2_{0.6,17} = .188$$

STEP 3

$$R_{0.6,17,7} = .461 \quad R^2_{0.6,17,7} = .212$$

STEP 4

$$R_{0.6,17,7,15} = .520 \quad R^2_{0.6,17,7,15} = .270$$


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## Chapter Six

### Distance

The purpose of this chapter is to consider how dental patients in Edinburgh react to distance. First, the geographic pattern of distances travelled is examined; this is followed by a description of the distance decay of trips to the dentist. As such this chapter links the previous two chapters by describing the geographic relationship between dental care provision and dental patients in Edinburgh - their respective topics.

"Dental treatment is mainly the result of interaction [between] two people, the patient and the dentist" (Gray, et al, 1970; p. 40). For the geographer distance is a major aspect of this interaction. Essentially, distance may be viewed as a barrier, inhibiting access to a facility. In terms of costs this may mean that the choice of a nearby surgery is made instead of one, which may be more attractive, but further away. Alternatively, more time and money may be expended in attending the more distant surgery. A more serious implication is that if the distances are relatively great this may result in the number of journeys to the dentist being restricted and, in extreme cases, curtailed altogether. In other words the effect of distance is to limit choice and, possibly, reduce demand.

Distance travelled, as a measure of spatial behaviour, may be of considerable value to the researcher or analyst. For example, location-allocation models may be used to derive 'equity' or 'efficiency' solutions to the problem of distributing a set of facilities. An equity solution may involve distributing facilities so as to favour the lowest income groups. The efficiency solution might involve maximising demand over the system of facilities as a

whole or to a particular facility. Both solutions are dependent on a knowledge of the spatial behaviour of users of the facilities. In a situation where a set of competing facilities already exists, for example dental surgeries, such a knowledge could be important in deciding whether one more facility was viable and where it would be optimally located.

When using distances travelled as a measure of behaviour the hope is that such behaviour is a direct reflection of choice. In practice, this may not be entirely true because the measures obtained are specific to the system under study. Hence, the distance travelled by each individual will be determined partly by the distribution of facilities, and partly by his choice of facility. If only the behavioural element of these measures is to be used, the structural component must first be removed.

A further complication is that demand may be elastic. In other words distance may curb the actual volume of demand, for example by causing visits to the dentist to be less frequent or by causing fewer people to attend a dentist, as well as influencing choice.

#### Behaviour and distance

The geographic pattern of distances between patients' homes and surgeries shows an interesting contrast. As distance from the city centre increases the mean distance travelled by patients in each cell tends to increase ( $r = 0.481$ , significant at the 0.05 level). At the same time, however, the relationship between the distance of each surgery from the city centre and the mean distance travelled to each

surgery shows an inverse relationship ( $r = -0.482$ , significant at the 0.01 level). That is, the more distant a surgery is from the city centre the shorter will be the average distance travelled to it. Thus patients who live in the suburbs tend to travel longer distances than patients from the centre, yet suburban surgeries have smaller catchment areas than central surgeries.

When distance is measured in terms of the 'rank' of surgery attended, instead of the actual distance travelled, a somewhat different picture emerges. The mean 'rank' of surgery attended for patients living in each cell shows no significant correlation with the distance of the cell from the city centre ( $r = -0.073$ , not significant). Thus, the distance that a patient lives from the city centre does not appear to influence the rank of surgery attended. However, to exercise the same range of choice suburban patients do travel longer distances than patients living in the central area, simply because the fifth nearest surgery, say, tends to be further away for suburban patients.

One possible implication of these results is that there are two types of suburban patient, one type travelling relatively long distances, and the other relatively short distances. Put another way, one group attend central surgeries and the other attends 'local', suburban, surgeries. To examine this proposition the SDEB sample of patients was categorised according to whether the surgery attended was three kilometres or less from the city centre, or more than this. The mean distance and rank were then calculated for patients in each category and cross-tabulated with age and sex.



Distance and rank revealed an interesting variation with age (Table 6.1). Firstly, for suburban patients the mean distance and rank travelled by patients aged 20 or less are lower than for patients aged 21 or more. This implies that, in the suburbs, 'local' surgeries are more attractive for younger rather than older patients. An obvious reason for this is that younger patients have relatively poor access to cars for their journey to the dentist (see Chapter Seven). They will thus tend to attend 'local' surgeries. Older patients on the other hand not only have better access to cars but are more likely to work in the city centre or make shopping trips there. Hence they have more opportunity and reason to attend central, or other more distant, surgeries.

Table 6.1

Mean rank and distance for patients attending central and suburban surgeries, cross-tabulated with age.

<u>Age</u>	<u>Central Surgeries</u>	<u>Suburban Surgeries</u>	
0 to 20	2.7	1.6	(Distance)
	22.9	10.2	(Rank)
21+	2.7	2.0	
	25.0	15.8	

---

Secondly, the figures reinforce the fact that suburban surgeries have more limited catchment areas than central surgeries. Overall it would appear that suburban surgeries are more likely to 'catch' younger patients than older ones. For the suburban surgery this is an asset, in terms of the volume of demand it might receive, because the mean age of patients living in each cell has an inverse

relationship with the distance of the cell from the city centre ( $r = -0.191$ ). That is, there are proportionately more young people in suburban housing estates, both private and council, than elsewhere in the city. To a certain extent this suggests that suburban surgeries have a 'captive market' in young patients. And because suburban surgeries are relatively far apart they may be able to exercise a certain amount of monopoly power over these patients. This is clearly important to the dentist. If his surgery is located in a suburban area with a high density of young people this would be one reason to expect a high volume of demand.

Dental health does appear to be associated with the distance that patients travel to their dentist (Table 6.<sup>2</sup>4), albeit to a limited extent. As the mean distance travelled to surgeries increases, the mean number of extractions for patients at these surgeries declines. So also does the mean duration of patients' courses of treatment. A similar result is obtained when the mean rank for patients at each surgery is considered instead of mean distance. In addition, with rank the mean number of missing teeth also declines.

Thus it would appear that surgeries with larger catchment areas attract patients requiring fewer extractions. At first glance one might assume that these would be central surgeries. Yet none of the variables is associated with the distance of the surgery from the city centre. Another interpretation of these results is that patients who are prepared to travel quite far to their dentist tend to take good care of their teeth,

In support of this notion it should be remembered that SEC has been shown to be associated with pattern of attendance (see Chapter Five). Questionnaire respondents in SEC1 were most likely to attend their

Table 6.2

Correlations between dental health and geographic behaviour. The mean number of missing teeth, the mean number of extractions and the duration of patients' courses of treatment, at each surgery, are correlated with the distance of each surgery from the city centre and with the mean distance and 'rank' travelled by patients attending each surgery.

	Distance from city centre	Mean Distance	Mean Rank
Mean number of missing teeth:	-.025	-.098	-.185*
Mean number of extractions:	.086	-.283**	-.237**
Mean duration of course of treatment:	.067	-.175*	-.172*

\*\* - significant at the .01 level

\* - significant at the .05 level

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dentist regularly, whilst those in SEC4 were least likely to do so. From the point of view of both distance and rank patients living in areas with large proportions of the population in SEC1 tended to travel relatively long distances (Table 6.5). Whereas patients from areas with large proportions in SEC4 did not. Thus it could be that surgeries to which patients travel relatively long distances and who have quite good dental health are in fact treating 'regular attenders', probably from SEC1.

One implication of this result is that surgeries are more likely to exert 'monopoly power' over 'lower status' patients than 'higher status' patients, because the former tend to travel shorter distances. And these patients are more likely to require more extractions than high status patients do. Thus it seems possible for

suburban surgeries to exercise a greater degree of 'monopoly power' over young or 'low status' patients.

Table 6.3

The correlation between the proportion of the population in each half kilometre square that are in each SEC and the mean distance and rank travelled by patients living in each square.

	<u>%SEC1</u>	<u>%SEC2</u>	<u>%SEC3</u>	<u>%SEC4</u>
Mean distance	.275**	.063	.046	-.151**
Mean rank	.241**	.113*	-.059	-.109*

\*\* - significant at the .01 level

\* - significant at the .05 level

---

This might be an important consideration for a dentist because, should he choose to site his surgery in a 'low status' area and enjoy a certain amount of spatial monopoly he could lose the opportunity to attract private patients. Of course this is speculation because the propensity of each SEC to generate private patients is not known. But on the basis of attendance behaviour (Chapter Five) it seems reasonable to assume that 'lower status' areas will not produce large numbers of private patients.

Equally, it could be that this type of implication is already a consideration for dentists opening new surgeries. Perhaps it always has been and the present distribution of surgeries is a reflection of it.

#### Distance decay

A distance decay curve shows the number of people travelling given

distances (Figure 6.1). Quite clearly most dental patients in Edinburgh travel relatively short distances. However this curve is of limited value; it simply describes a particular set of observations. Implicitly contained within it is the effect of the spatial structure of Edinburgh on behaviour. This stems from the distribution of surgeries and of patients.

In this section the objective is to consider behaviour and distance to see how distance influences choice. To achieve this the structural effect must be removed. At present the curve in Figure 6.1 allows one to say that approximately 380 patients attended a dentist within half a kilometre of their home. However, in this form the curve says nothing about the propensity of patients to travel given distances, it simply describes the number of patients that travel different distances and not the choices that they make. What is required is the ability to identify the proportion of those who could have attended a dentist within half a kilometre, or any other distance band, that actually chose to do so. Thus, for example, if 250 patients had travelled less than half a kilometre and 500 patients could have attended a dentist in that distance range, had they wished to, this would transform to a rate of 500 patients per thousand who actually chose to attend a dentist in that distance band. By re-expressing the figures in this way the effect of choice is highlighted (Figure 6.2). A curve such as this allows comparison between distance zones, because a standard metric has been used. It also permits comparison with other studies, so long as their figures are also standardised. However, the structural effect - the fact

FIGURE 6.1 .

THE NUMBER OF SURVEY RESPONDENTS TRAVELLING GIVEN DISTANCES

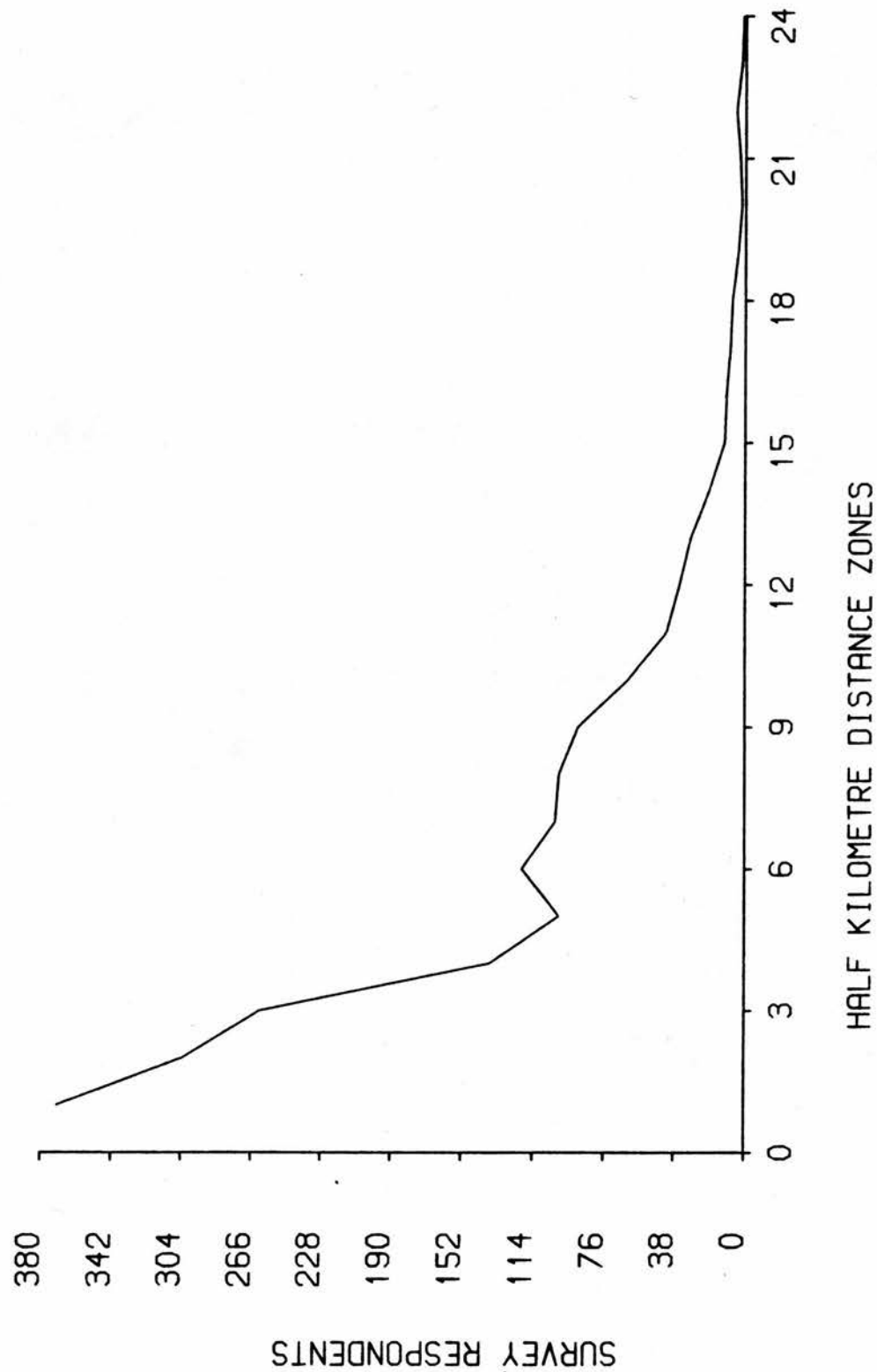
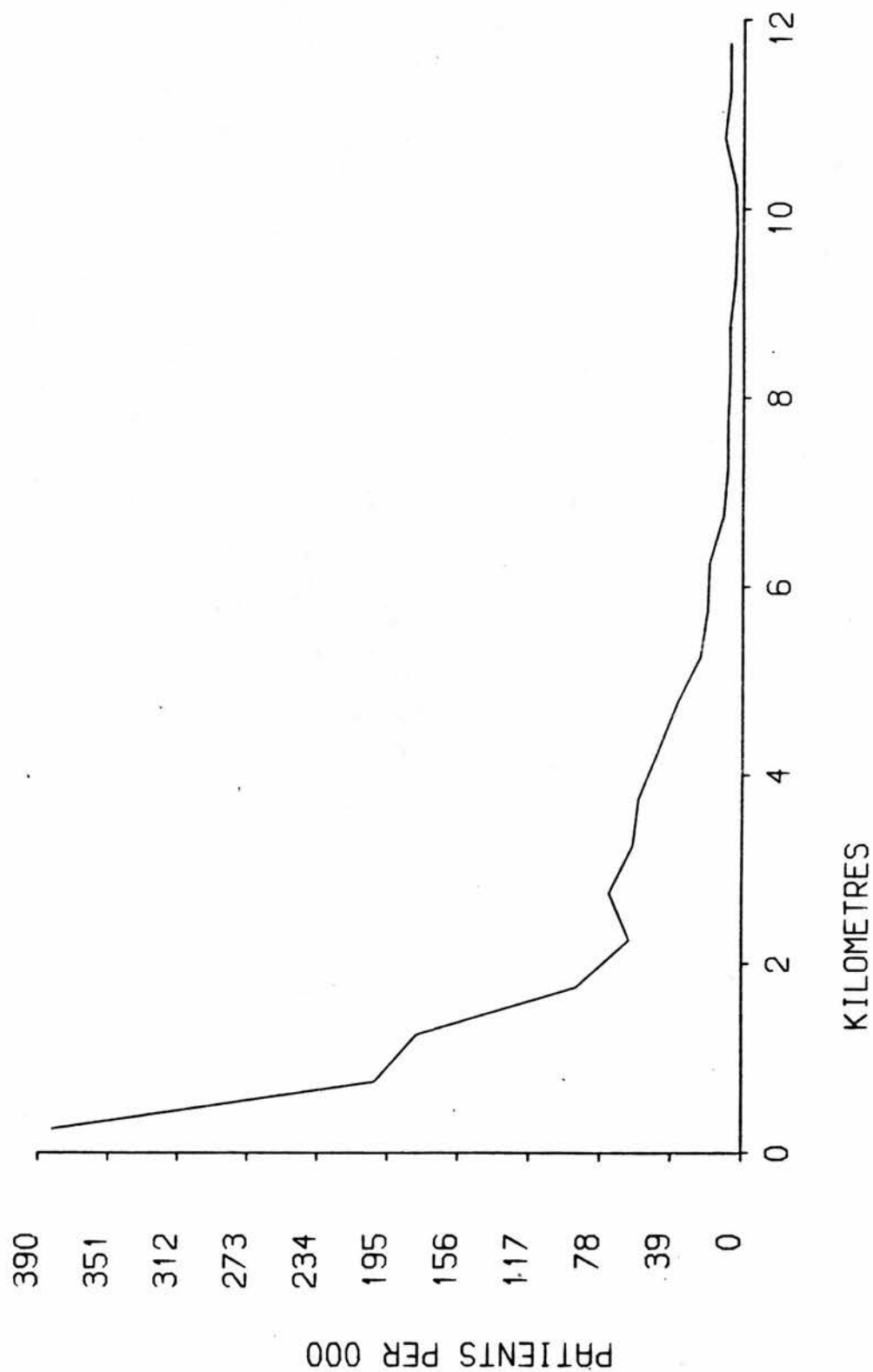


FIGURE 6.2.

THE NUMBER OF SURVEY RESPONDENTS TRAVELLING GIVEN DISTANCES, EXPRESSED  
AS A RATE PER THOUSAND OF THOSE WHO COULD TRAVEL THOSE DISTANCES



that this study was conducted in Edinburgh, rather than Glasgow or Aberdeen - has not been completely eliminated. The number of distance zones reflects the maximum dimension of the study area. The maximum distance travelled was between 11.5-12 kilometres. In a larger city the maximum distance travelled could be greater than this, and in a smaller city it could be less. To determine whether this basic structural element, city size, has any influence on behaviour would require comparisons between cities of different sizes, and is outwith the scope of this study.

The distance decay curve now reflects the spatial choices and behaviour of all patients in the sample. However, it may also have been influenced by the effect of elasticity. That is, some people may not have been patients because the distance to their nearest surgery was too great. In economics, if the price of a good is too high demand for that good declines, or ceases altogether. Geographically, the distribution of a set of facilities confers a set of accessibility costs and benefits (see Chapter Four). Distance can only be overcome at a cost, whether in terms of money or time. If the cost of using dental care is high it may be used less frequently or not at all.

Spatial elasticity of demand should only be considered in relation to the distance to the nearest surgery. In economics, price elasticity of demand is considered in relation to a given price range, though at any one time there can only be one price. Similarly in geography, there will be a range of distances because different places are different distances from the nearest surgery. If distances beyond



the nearest surgery are considered that would imply that the distance to the nearest surgery has little or no impact upon demand for dental care, in which case demand quite clearly cannot be elastic. On the other hand, if other factors such as surgery capacity (see Chapter Ten) are considered, distance to the nearest three or four surgeries may become quite important.

Spatial elasticity of demand, therefore, relates total demand in an area, per thousand population, (or some other standardised measure) to access to supply in that area. In other words, demand is responding to spatial structure.

The objective of an analysis of the spatial elasticity of demand is to derive a curve which demonstrates how demand varies with distance. The curve should have a negative slope and indicate that as distance increases demand declines. As such it would be possible to determine how much demand is being lost to the system due to the existing distribution of surgeries. By applying such a curve to the situation facing each cell the amount of demand which is lost in each cell could be calculated. Those values could then be mapped and areas losing large amounts of demand identified. Such areas might then be used as target areas for new surgeries.

Unfortunately, the evidence for Edinburgh is not clear. The association between the proportion of patients in each cell and the distance of each cell to the nearest surgery is not significant ( $r = 0.001$ ), suggesting the absence of elasticity. However, another way of analysing the data is, by finding the nearest surgery to each

cell, to identify a 'set' of 'nearest' surgeries and examining the proportion of patients in distance zones around them. If demand is elastic the percentage of patients should decline with distance, if not there should be no decline. The figures indicate (Table 6.4) that beyond 1.5 kilometres there is a decline in the relative proportion of dental patients. Thus elasticity could be present.

However, in Edinburgh where the maximum distance to a 'nearest' surgery is relatively short it was not expected that spatial elasticity of demand would be found. The very small percentages in Table 6.4 should be treated with extreme caution, and as having little or no effect on the distance decay curve. As has been shown a large proportion of patients travel fairly short distances, yet many choose to travel moderately long distances, clearly beyond their nearest surgery. If elasticity of demand was present it is likely that choices such as these would be very much more curtailed than they are. Thus one may conclude that the standardised distance decay curve above (Figure 6.2) is an accurate representation of choice. From this one can infer that most patients prefer to attend a dentist close to their home simply because it is closer.

Table 6.4

The percentage of the population that are patients in each half-kilometre distance zone around 'nearest' surgeries.

	<u>Distance Zones</u>				
<u>% Patients</u>	<u>0-0.5</u>	<u>0.5-1</u>	<u>1-1.5</u>	<u>1.5-2</u>	<u>2-2.5</u>
	0.98	0.95	1.09	0.85	0.5

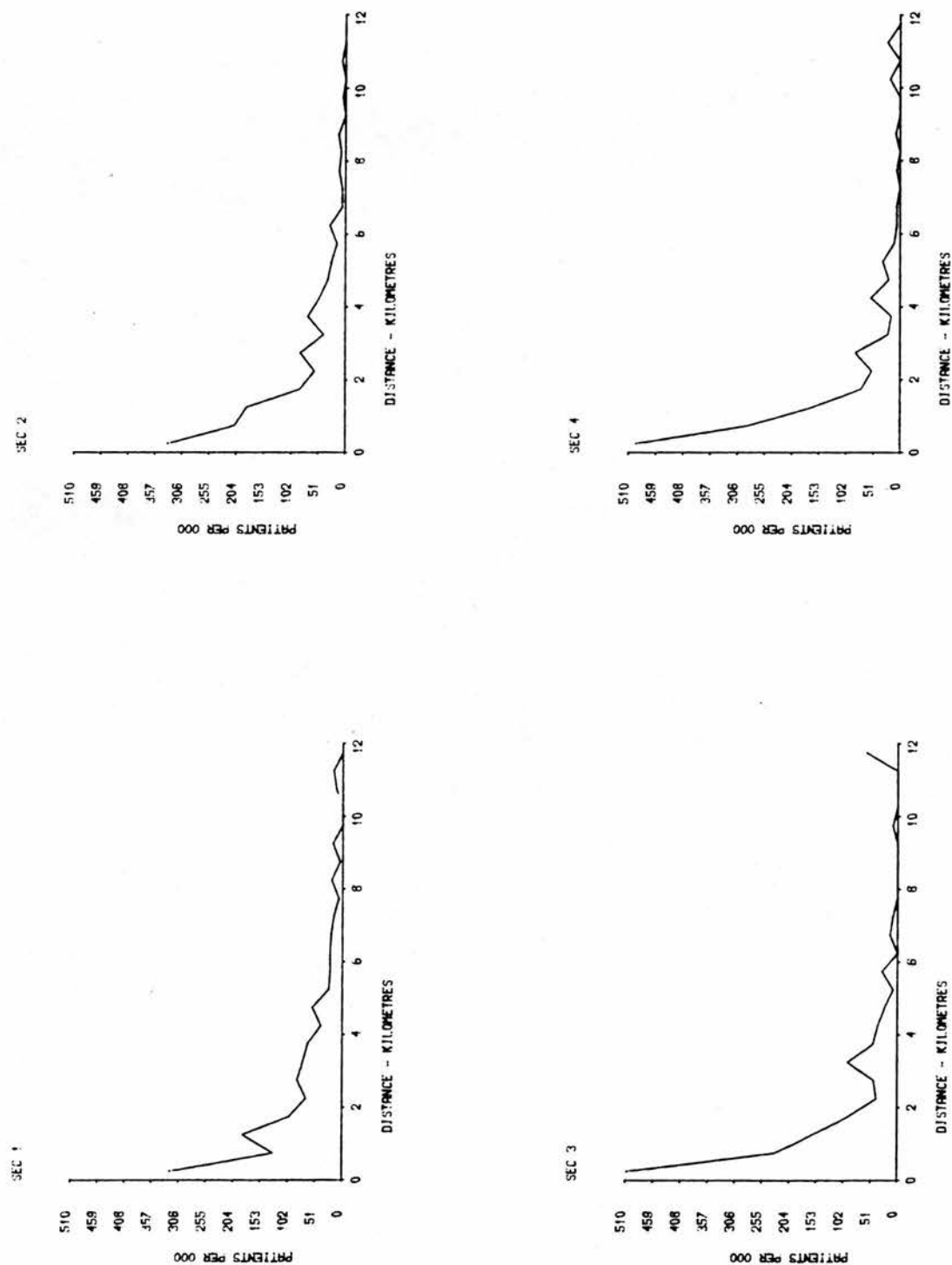
By plotting curves for different population sub-groups, differences

in their behaviour may be observed. In Chapter Five it was shown that SEC was fairly strongly associated with the probability of being a patient. This is reflected by differences in spatial behaviour of the corresponding sub-groups of dental patients (Figure 6.3). The major observable difference is that between SECs 1 and 2 and SECs 3 and 4. SECs 3 and 4 show a greater desire to attend surgeries close to their homes than do SECs 1 and 2. This reinforces the similar finding earlier in this chapter. The distinction between the two groups is apparent only for those surgeries within one kilometre of patients' homes. Surgeries further afield are equally well attended by different SECs. However, we already know that most patients attend surgeries within this distance of their homes (Figure 6.1). Thus, the propensity to travel relatively long distances is lower in SECs 3 and 4, and would suggest that if spatial elasticity of demand does exist it would most probably be manifested in these sub-groups.

From the point of view of supplying dental care this difference has some significance. It would suggest that dental surgeries could be located in high density council estates and still attract enough patients to be viable. The fact that the 'lower status' groups in the population have lower propensities to be dental patients could be offset by the higher proportion attending the local surgery. Local dental authorities could help a dentist about to establish a surgery by pointing out suitable locations. In this way the planning of dental care provision and the entrepreneurial spirit of dentists could be harmonised.

From the point of view of location-allocation modelling the

FIGURE 6.3 STANDARDISED DISTANCE DECAY CURVES FOR EACH SEC



difference between the two groups of SECs is very important. Models that use only one distance decay coefficient are essentially using an average measure of behaviour (that is, if it has been measured empirically). If this were done for the case of dental patients in Edinburgh the effect would be to assume that patients in SECs 1 and 2 have a higher propensity to travel short distances than they in fact have; and to assume that patients in SECs 3 and 4 have a lower propensity to travel short distances than they actually have. Other things being equal, a distribution of surgeries based on this method would result in more surgeries being situated within the 'action spaces' of patients in SECs 1 and 2. Clearly this would simply reinforce the existing distribution of surgeries.

The knowledge that there are differences in spatial behaviour between population sub-groups, and that these differences can be summarised by distance decay curves, gives modellers the opportunity to generate distributions that favour selected sub-groups. The usual method of incorporating spatial behaviour into location-allocation and gravity models is by the calibration of distance decay exponents. It is valid at this point to assess the accuracy with which the spatial behaviour of different groups could be predicted on the basis of distance decay exponents derived by this study.

Because distance decay curves are normally very positively skewed the calculation of exponents often involves data transformation to enable a simple linear regression model to be fitted to the data. The immediate problem then becomes one of identifying the transformation that gives the best fit of the data to a straight line. In this

study the approach adopted follows that of Taylor (1971 and 1975). He showed that a family of decay functions exists based on the general model:

$$\text{Log } I = a - bf(d)$$

where:

$f(d)$  is some transformation of distance;

$\text{Log } I$  is the log (to base  $e$ ) of the number of patients choosing to travel a given distance;

$a$  and  $b$  are parameters.

Taylor used five different models:

Exponential:  $\text{Log } I = a - bd$

Normal :  $\text{Log } I = a - bd^2$

Square root exponential:  $\text{Log } I = a - bd^{0.5}$

Pareto:  $\text{Log } I = a - b \log d$

Log-normal:  $\text{Log } I = a - b(\log d)^2$

He found that, for migration data from Asby in Sweden, the square root exponential model gave the best fit.

When these are applied to the standardised distance decay curves for each SEC (Table 6.5 and Figures 6.4 - 6.8) some interesting observations may be made. Taking the standard error of the estimate, i.e. the standard deviation of the residuals, as the measure of goodness of fit, the square root exponential model provides the best fit for SECs 3 and 4, whereas SECs 1 and 2 are best fitted by the exponential model. Thus, the model identified by Taylor as giving the best fit in his study does not apply to all the sub-groups in

Figure 6.4 Exponential Transformations

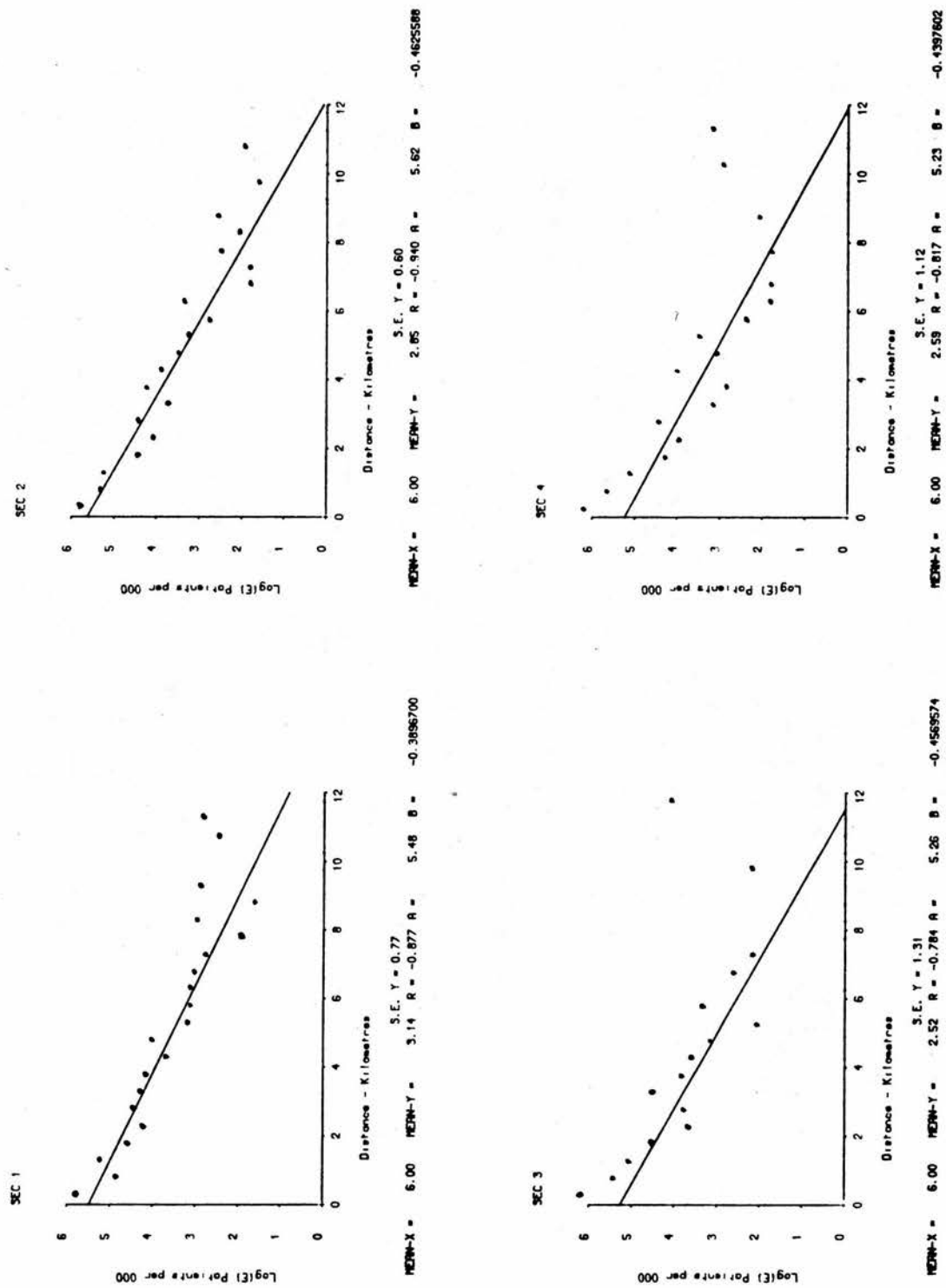


Figure 6.5 Normal Transformations

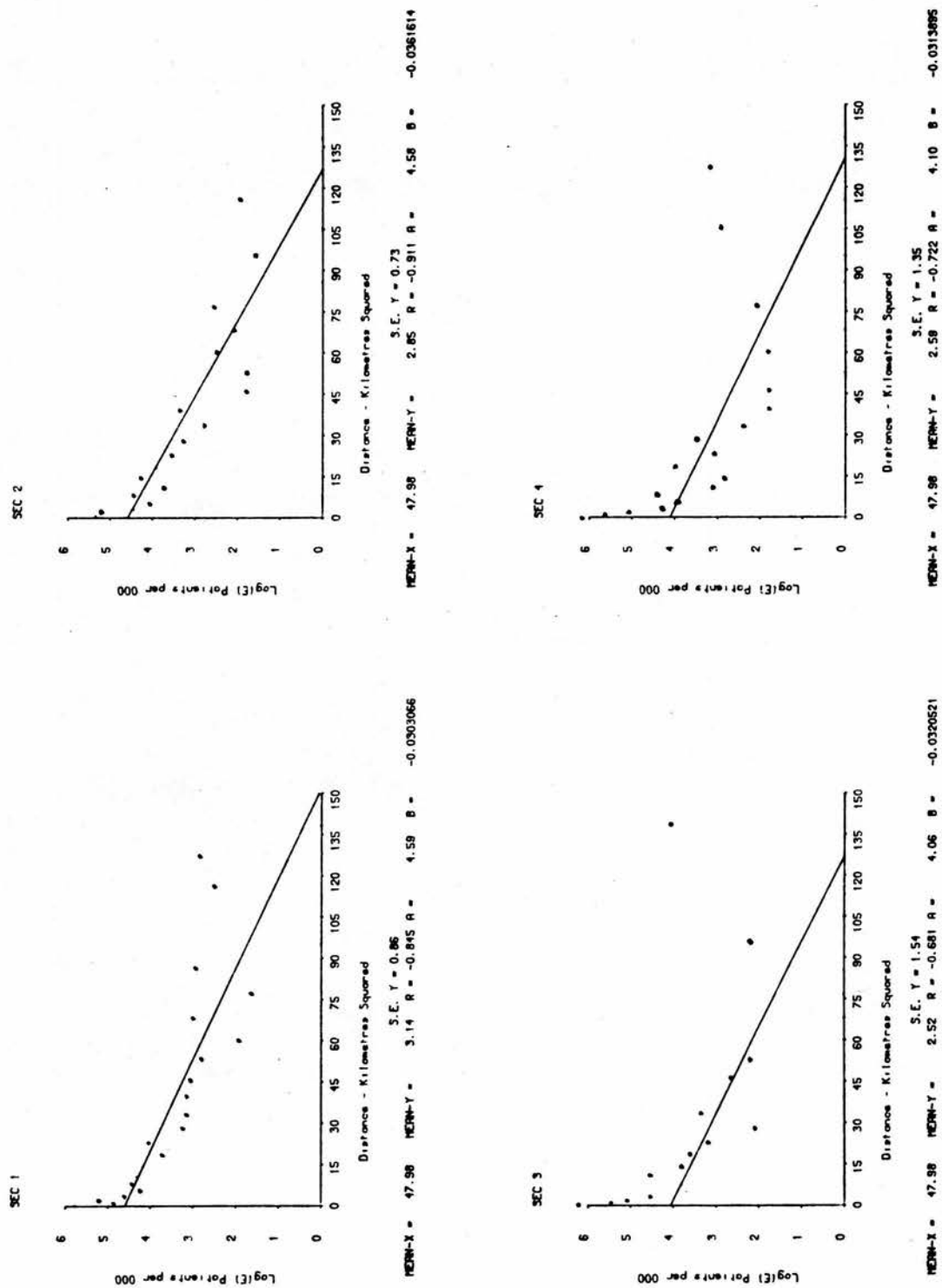




Figure 6.6 Square-Root Exponential Transformations

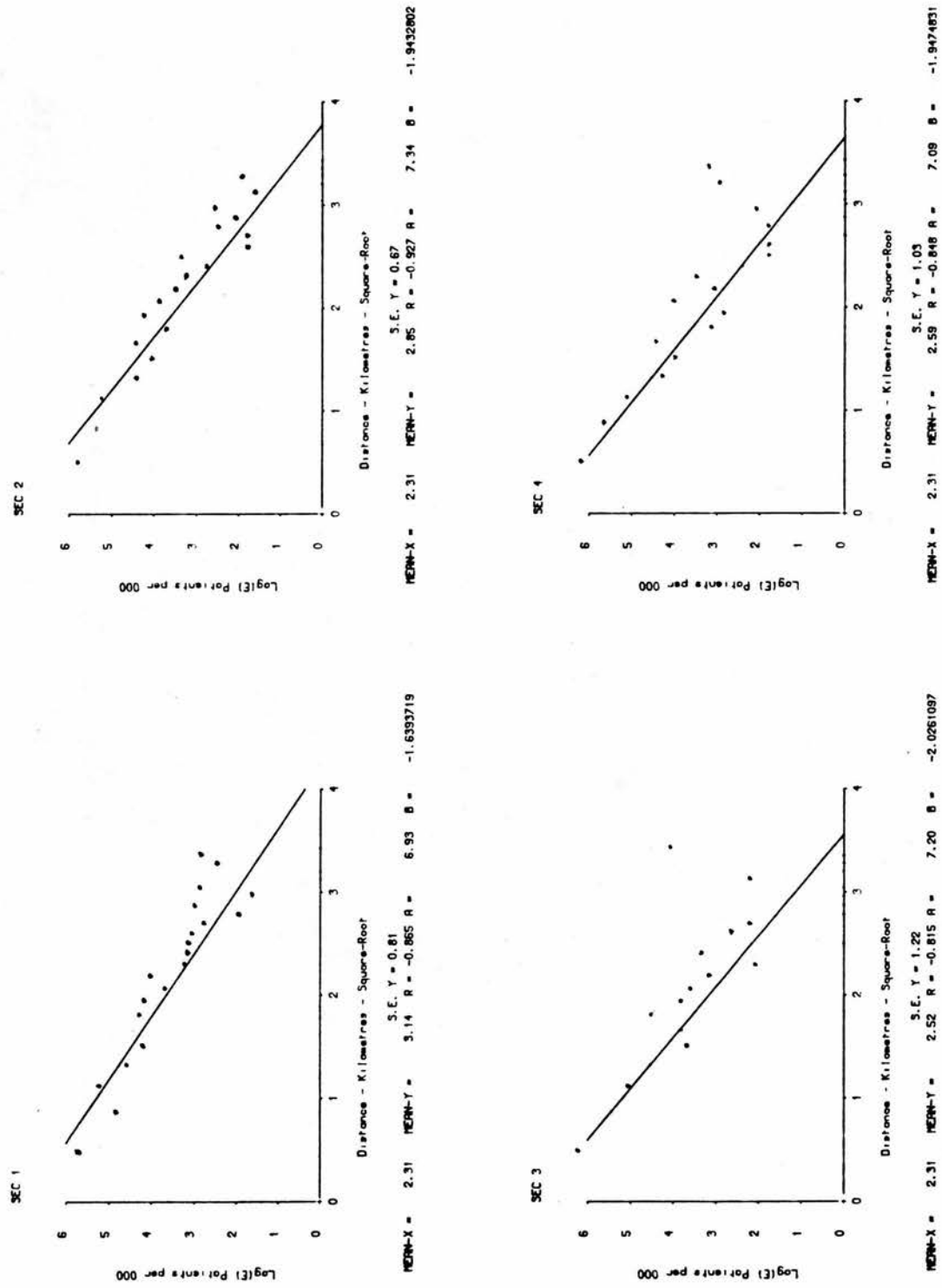


Figure 6.7 Pareto Transformations

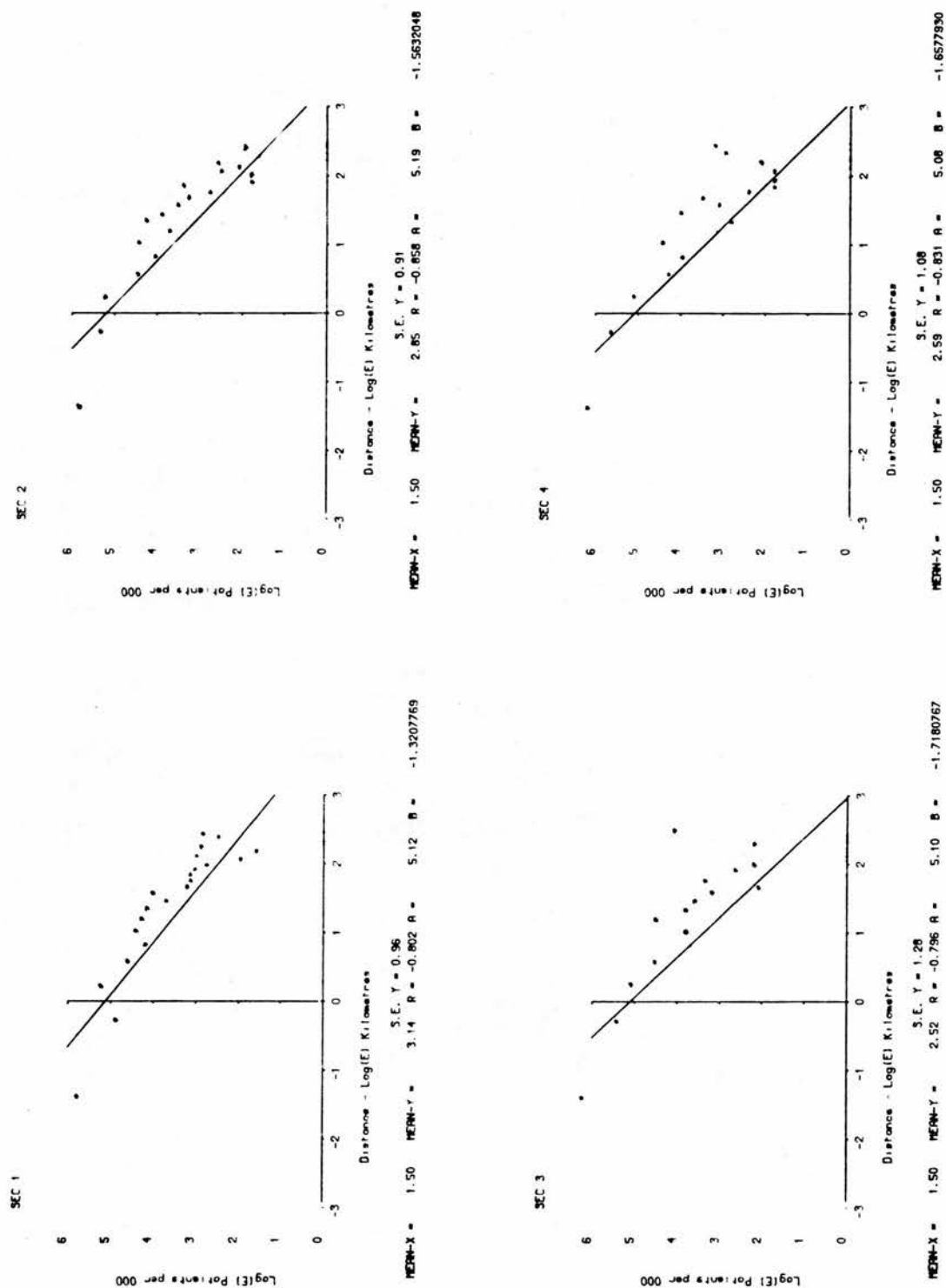
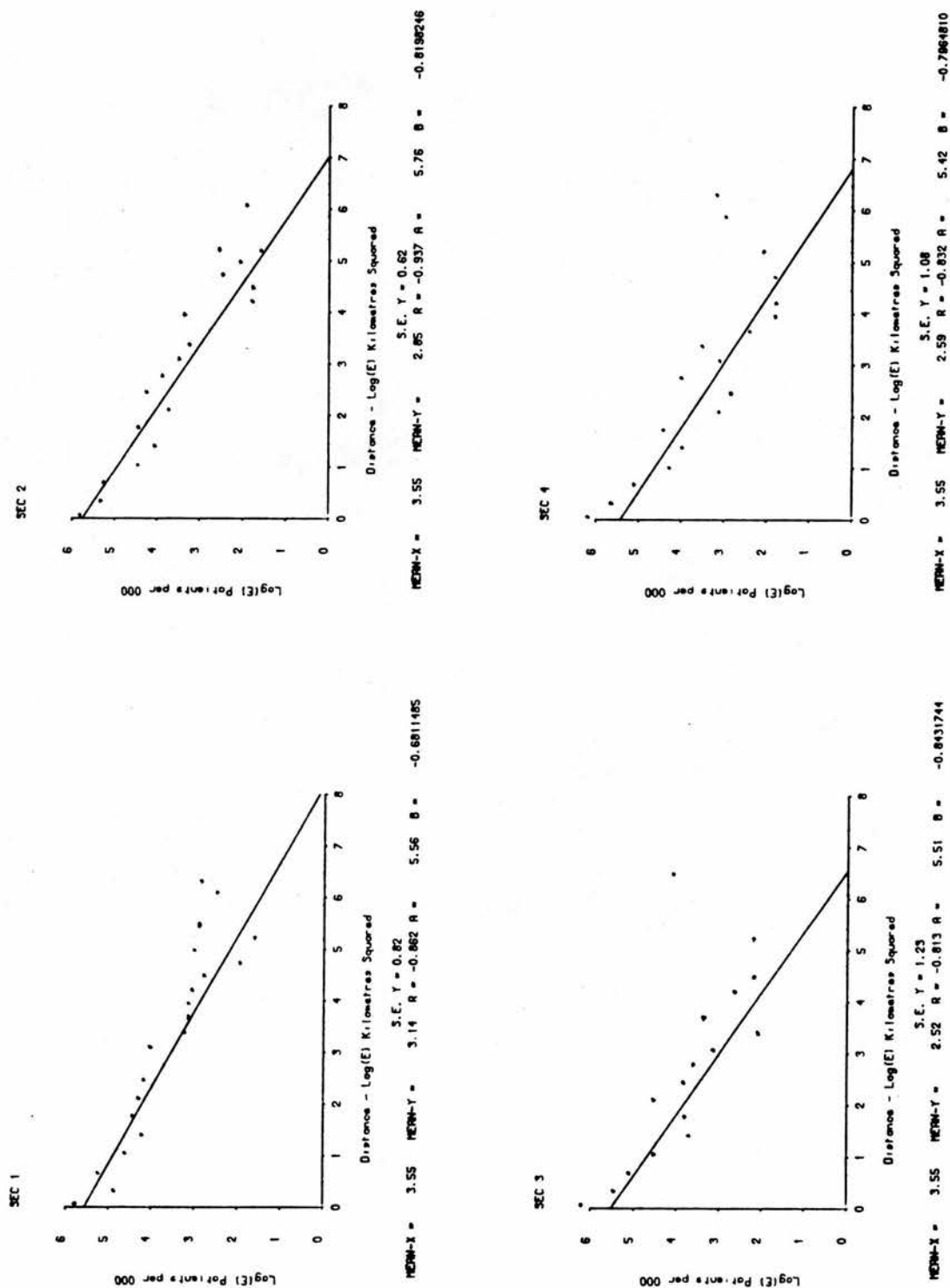


Figure 6.8 Log-Normal Transformations



this study. Indeed, the square root exponential model is the overall

Table 6.5

The result of different transformations on the standardised distance decay data for each SEC.

EXPONENTIAL MODEL

	<u>r</u>	<u>a</u>	<u>b</u>	<u>SE.Y</u>
SEC 1	-.87	5.48	-.3897	.77
SEC 2	-.94	5.62	-.463	.60
SEC 3	-.784	5.26	-.457	1.31
SEC 4	-.817	5.23	-.440	1.12

NORMAL MODEL

SEC 1	-.845	4.59	-.03	.86
SEC 2	-.911	4.58	-.036	.73
SEC 3	-.681	4.06	-.032	1.54
SEC 4	-.722	4.10	-.031	1.35

SQ. RT. EXP. MODEL

SEC 1	-.865	6.93	-1.64	.81
SEC 2	-.927	7.34	-1.94	.67
SEC 3	-.815	7.20	-2.03	1.22
SEC 4	-.848	7.09	-1.95	1.03

PARETO MODEL

SEC 1	-.802	5.12	-1.32	.96
SEC 2	-.858	5.19	-1.56	.91
SEC 3	-.796	5.10	-1.72	1.28
SEC 4	-.831	5.08	-1.66	1.08

LOG NORMAL MODELS

SEC 1	-.840	5.26	-.68	.87
SEC 2	-.903	5.37	-.81	.76
SEC 3	-.757	5.03	-.80	1.38
SEC 4	-.781	4.98	-.77	1.21

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'best fit' model because it is also second best for SECs 1 and 2, whereas the exponential model is not second best for SECs 3 and 4.

This variation in best fit models between high and low status groups essentially reflects the observed patterns in Figure 6.3. SECs 1 and 2 were shown to have a less steep decay curve in the lower distance zones than SECs 3 and 4. Data transformations are intended to 'knead' the data, essentially to remove skewness. The exponential model leaves the distance variable untransformed, whereas taking the square root of distance essentially swivels the regression line in a clockwise direction about the mean of Y (Log standardised patients per distance zone). In this way the slope of the lines are made steeper - as indicated by the 'b' values - and what was under-prediction for SEC 3 and 4 at the critical left hand end of the curve becomes nearly a perfect fit.

The left hand of the line is critical because the Y variable has been logged and the b values are negative. Thus, the intercept of the slope occurs quite high up on the y axis, at a point where if the values are 'anti-logged' even small residuals could represent large numbers of patients. Consequently, even though there is only slight under prediction by the exponential model of the behaviour of SECs 1 and 2 this could be quite significant if the calculated exponent was used in an interaction model. However it should be noted that if this exponent is used for locating facilities it could tend to push facilities away from high status people. From the point of view of social justice this could be a legitimate objective for planners and might encourage the use of such an exponent.

A rather unexpected result was that the predicted intercepts were

completely the reverse of what would be expected given the data in Figure 6.3. SECs 1 and 2 had higher intercepts than SECs 3 and 4, no matter which transformation was used. The probable reason for this is that the log value of the Y variable gives undue influence to tail-end values. SEC 3 and 4 both have minor peaks in the tails of their distance decay curves (Figure 6.3). When the data have been logged these peaks have undoubtedly swivelled the regression lines for SEC 3 and 4 in an anti-clockwise direction, thus lowering the intercept.

Thus, there are grounds for not using distance decay exponents calculated by transforming models. From the models used in this study it can be seen that predictions based upon them could contain two types of error. Firstly they could tend to underpredict SECs 1 and 2 in the critical left hand area of the curve. Secondly, estimates of the intercept do not concur with the observed pattern, and would thus tend to compound prediction error.

It should be noted that, for interaction models of any sort, an alternative is to not calculate an exponent at all. Instead, actual observed propensities could be used, in the form of an array of propensities. Each value in the array would be a measure of the propensity to travel a given distance. When used in a model the position of the value in the array would indicate the distance band to which that particular propensity applied. Thus, the first value would apply to the first band, and so on. Each sub-group could have its own array of propensities.

## Conclusion

This chapter has shown that the distances travelled by different groups vary considerably. In terms of behaviour and distance two patterns emerged. First, suburban patients travel longer distances than central patients. And second, patients who attend suburban surgeries travel shorter distances than those who attend central surgeries. From these contrasting results it was speculated that there were two types of patient living in the suburbs. The evidence of this study was that age was an important factor in determining the distance travelled by suburban patients. Young patients were more likely to be 'caught' by suburban surgeries, whereas older patients tended to exercise wider spatial choices.

Some evidence was also presented which showed there was a relationship between the distance travelled by patients and their dental status. Patients travelling longer distances tended to have slightly better dental health than those travelling shorter distances. The reason for this, it was speculated, was that patients travelling longer distances were more likely to be committed to maintaining their dental health. An associated reason was that these patients were 'high status' patients. In Chapter Five it was shown that these patients were more likely to be regular attenders than were 'low status' patients.

In terms of distance decay and choice, a very strong preference for surgeries fairly close to home was uncovered by plotting distance decay curves. Elasticity of demand did not appear to be affecting the shape or slope of this curve. Clear differences between SECs 1 and

2 and Secs 3 and 4 were observed in their reaction to the 'friction of distance'. The latter two SECs being much more likely to choose a surgery close to home than were SECs 1 and 2.

Some brief comments on the predictive accuracy of distance decay exponents calculated from the data used by this study were made. It appeared that, from the transformations examined in this section, serious errors could be made if these exponents were incorporated into a model because of under or over prediction at the left hand end of the distance decay curve. An alternative to calibrating a distance decay curve was suggested. This would involve the use of a data array, with each element in the array relating a propensity to make a particular choice with a given distance.



## Chapter Seven

### Mobility

In the previous chapter the distances travelled by patients were described and some differences between the various SECs were noted. No account was taken of the effect that different modes of travel might have on those distances. That will be remedied in this chapter where 'personal mobility' is the focus.

'Personal mobility' refers to the locomotive ability of individuals to move around in geographic space. As such there are a number of factors that come to bear upon it. Besides the ability to walk, which will be taken for granted in this study, perhaps the most important factor is access to private transport, notably a car. Access to private transport confers two benefits upon an individual:

- a) travel becomes easier for him in the sense that much of the 'friction of distance' is overcome;
- b) it enables him to travel in any direction, an important consideration when contrasted with journeys by bus along pre-defined routes.

As will be seen later, the use of a car is the most common mode of private transport, numerically much more important than bicycles and motor-cycles. During the early post war years the rapid rise in car ownership led many people concerned with the provision of public services to consider that the problem of access was of diminishing importance (Sumner, 1971; Phillips, 1979). However, despite the numerical superiority of travel by car over other modes of private transport, the rise in car ownership has not resulted in improvements in personal mobility for all sections of the population. The majority of car owning households own only one car. This is often used by the

husband for his journey to work, leaving his wife and children to either walk or travel by bus on their day-time journeys. In addition, not everyone in car owning households can drive. They must therefore rely on being driven by those who can. Thus, there are many people who cannot enjoy the benefits of private transport. The effect of not having private transport is not simply to restrict such people to either walking or travel by bus. It also means that these people have no way of reducing to minimal levels the 'friction of distance' that they face. They are therefore subject to the harsher decrees of the 'tyranny of space'.

The problem of personal mobility is well recognised in the literature, especially that dealing with rural situations. A report by the Welsh Hospital Board (1973), dealing with the cost of travelling to hospital in Wales, noted that one of the biggest problems facing travellers was the inadequacy of public transport. Consequently, those having the poorest accessibility to hospital care were those without cars. Furthermore the problem was continuing to get worse, partly because of the steady decline in both bus and rail services, resulting in longer and more expensive journeys. The process of centralising hospital services was also noted as compounding this effect.

Inadequate public transport was also recognised as a major problem by Wheeler (1972) when he considered the accessibility of a hospital in a rural area of England. He argued that public transport services were declining because of the increase in car ownership and because of the increase in contract bus services. As noted earlier, the

benefits of increased car ownership have not been distributed evenly through the population. Wheeler's argument shows that the increase in car ownership also has the more insidious effect of making travel more difficult for those without a car. Consequently, many patients included in Wheeler's study were found to live in villages where public transport was non-existent or very poor. One third of the patients surveyed had no direct public transport service to the hospital town, and 57 per cent of bus journeys took over one hour. Apart from the problem of actually travelling, there is another problem arising from that of infrequent bus services: it becomes difficult to synchronise journeys to appointment times. As a result, Wheeler found that some patients gave whole days over to attending an out-patient clinic. A similar result was found by Gruer (1972) for patients living in the Scottish Border Counties attending hospital out-patient clinics in Edinburgh. The effect is multiplied if the patient has to be accompanied on the journey, as is often the case with children and the elderly, and becomes more serious if the patient is required to take a whole day off work.

Haynes and Bentham (1979), in a study of the use of hospitals by people living in the rural area of the King's Lynn Health District also noted the poor availability of public transport. Forty two per cent of the district's population lived '... in parishes served by less than 15 buses per day (in any direction) and for 12 per cent there is no bus service at all.' They then went on to consider the effect hospital accessibility has on the rates of visiting patients in hospital and on being admitted to hospital as either an in-patient or an out-patient. The data for this study was collected by

interviewing people in two types of village: one with good accessibility to hospital and the other having poor accessibility. Unfortunately they define good accessibility as being within eight miles of King's Lynn and having a good bus service to it. Poor accessibility arises if the village is between 14-20 miles from King's Lynn and is less well connected to it by public transport. This research design does not allow the separation of the effects that distance and poor personal mobility may each have on the behaviour under study. Nevertheless, accessibility did appear to influence the spatial behaviour of both visitors and patients. Those with poor accessibility visited patients in hospital less frequently and made less use of hospital care than those with good accessibility.

Personal mobility has also been considered in an urban context. Phillips (1978, 1979), because of the research design he adopted, was able to show that variations in the modes of transport used by patients travelling to their GP, were class related. Low status patients being relatively more likely than high status respondents to travel by bus, whilst the reverse was true for travel by car. He argued that the greater use of bus services by low status respondents was, in part, a substitute for lack of car ownership, allowing people to travel distances that would be too great to walk.

In 1971 Bristow and Bostock studied the accessibility of the Wythenshawe Hospital complex, on the south-western edge of the Manchester Conurbation. Part of the rationale for their study lay in the fact that some modern hospitals are built on 'green field' sites

outwith the urban area and they wished to examine problems of accessibility that this imposes. They noted that public transport in the area was geared for journeys to work, transport provision to the hospital being a secondary consideration. The reasons for this were that the number of passengers generated by the hospital was insufficient to warrant the upgrading of local bus services. Like Wheeler, they noted that as car ownership increases, the economic viability of existing bus services was likely to worsen. They concluded that the best that could be hoped for in alleviating the problem of poor accessibility, within the existing set of circumstances, was better connection of the hospital into the bus network. More satisfactory solutions to the problem might consist of subsidising the public transport authority to allow them to provide a more comprehensive service to the hospital. Alternatively, the hospital itself might be allowed to provide its own private bus service. Both of these solutions would require more money, and whether that should or should not be provided is a political question. Presumably, by saying this, Bristow and Bostock are offering little hope for implementing these solutions, at least not until the problem becomes critical.

In a study of the effect of social class and car ownership on intra-urban shopping behaviour, Thomas (1974), like Phillips, also found that car ownership was a class related phenomenon. Indeed, this was true to such an extent that, where behavioural differences could be discerned, they appeared to be more strongly associated with class than with car ownership. Nevertheless, he did show that, for grocery shopping, high status respondents travelled longer distances to

higher hierarchical levels. This, he argued, was directly related to their greater use of private transport for shopping trips.

Consequently, he suggested that more mobile populations require a wider choice of convenience goods than is available in neighbourhood centres. Furthermore, differences in behaviour between low status respondents were seen to be strongly influenced by differences in personal mobility - i.e. car ownership.

In terms of spatial behaviour this suggests that dental patients with poor personal mobility must restrict their choice of dentist to one of those within walking distance or spend relatively large amounts of time travelling by bus. Even travelling by bus does not allow the patient a similar spatial choice to that enjoyed by a patient who travels by car. In addition to the slower travel speed, bus routes effectively change the nature of space. Private transport enables the user to select any route he chooses between an origin and destination. He can travel in any direction (within the confines of the road network) and thus have the opportunity of maximising his accessibility by travelling along the shortest route. Bus users, on the other hand, suffer from a 'corridor' effect. They can travel in only the directions that are allowed by nearby bus routes. Bus services in Edinburgh display a marked 'radial' pattern, focusing on Princes Street and radiating out along the major arterial roads towards the suburbs. It is theoretically possible to move between any two points within the city using a maximum of only two buses. But for people living in the suburbs the bus routes available to them effectively limit their choice of direction towards the city centre and on to the diagonally opposite suburb. In other words, bus users

face a 'dental care opportunity surface' which is markedly different from that of car users, in that space is extended along bus routes, each route being separate from others except in the city centre. The result is that places that may be relatively close in terms of road distance can be very far apart in terms of bus travel, because they happen not to be in the same sector of the city and, hence, not served by the same bus routes. Thus access to private means of transport may be a major influence on the choice of dentists available to a patient.

It is therefore to be expected that the spatial choice of patients without private transport will be somewhat more restricted than those with private transport. A consideration of which patients use which modes will provide insight into the distribution of costs and benefits imposed by the possession or lack of private transport.

Having described the background, the remainder of this chapter will:

- a) identify the modal split for dental patients in Edinburgh and examine how it relates to the other factors under discussion;
- b) describe the distribution of costs and benefits between users of different modes, and draw some implications from this.

#### Modal split

Walking is the most usual mode (37.5%) followed by travel by car (31.6%) and travel by bus (28.0%) (Table 7.1). Other modes of travel (cycle, motor-cycle and other) were not numerically important, comprising only three per cent of respondents. The following analysis therefore will focus only on the three major modes of transport.



Table 7.1

The modal split

<u>Mode</u>	<u>Number</u>	<u>%</u>	
Walk	633	<del>37.4</del>	35.7
Cycle	16	0.9	
Bus	510	<del>27.9</del>	28.8
Car	576	<del>31.6</del>	32.5
M/cycle	20	1.1	
Other	18	1.0	

---

1773 100.0

That the largest modal group comprises those patients who walk to the dentist undoubtedly reflects the fact that the questionnaire was conducted in an urban area. Consequently, there is a high density of dental surgeries available in a relatively small area. For the urban resident this means that there may be many opportunities for dental care within easy walking distance. This is especially true for patients whose origin for their journey to the dentist is within the city centre. Clearly this applies not only to people who live in the city centre but also to those making use of other city centre opportunities - such as working or shopping - before attending their dentist.

Another reflection of the urban environment is the fact that approximately equal proportions of patients travelled by car and bus. This mostly mirrors the availability of buses, especially into the city centre where the highest density of surgeries is situated. In a rural environment, where bus services would be much less frequent, a smaller proportion of bus travellers might be expected.

From responses to the questionnaire it was possible to measure the

performance of each mode (Table 7.2). Of course these are not precise measurements, but they do allow general indications to be obtained. By calculating the journey time for each respondent and dividing by the distance travelled, a measure of travel speed was obtained. As would be expected, shortest average distances were travelled by walkers (1.1 kilometres), in a mean time of 13 minutes. This makes the average travel speed for walkers nearly five kilometres per hour.

Table 7.2

The mean distance, time and speed travelled by questionnaire respondents using each mode.

<u>Mode</u>	<u>Mean Distance</u>	<u>Mean Time</u>	<u>Mean Speed</u>
Walk	1.1 (1.7)	13.2 (12.4)	4.9 (8.9)
Bus	3.7 (4.6)	32.3 (18.0)	6.4 (5.3)
Car	5.9 (11.5)	18.7 (16.8)	13.8 (13.7)

Figures in brackets are standard deviations

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There is a considerable difference in the distances travelled by bus and car users. Car travellers, on average, journey six kilometres and bus users four kilometres. On the other hand bus users travel for a mean time of thirty-two minutes compared with nineteen minutes for car travellers.

#### Costs and benefits

Clearly, each mode has implications for the accessibility of dental care and it is of interest to identify the costs and benefits related

to them. To this end the distribution of car ownership, ability to drive and mode used will be described in terms of the sex, SEC and age of questionnaire respondents.

### Sex

Fewer males (35.3%) than females (40.7%) are from households owning no cars, though the difference is slight (Table 7.3). However, it does imply that relatively more females will choose a local dentist or make time consuming journeys by bus. This difference is mirrored by the ability to drive (Table 7.4). A large majority of males (68.5%) hold driving licences, whilst the majority of females (53.7%) do not.

Table 7.3

The percentage of males and females from households owning given numbers of cars.

<u>Cars</u>	<u>Males</u>	<u>Females</u>
0	35.3	40.7
1	47.8	46.7
2	13.8	11.2
3	2.4	1.2
4	0.1	0.2
5	0.4	0.0

Table 7.4

The percentage of respondents in each sex with driving licences.

	<u>Males</u>	<u>Females</u>
With	68.3	46.3

The resulting distribution of mode of travel by sex (Table 7.5) is as would be expected given these patterns of car ownership and ability to drive. Relatively more females walk or travel by bus, and

relatively more males travel by car.

Table 7.5

The percentage of each sex travelling by each mode of travel.

<u>Mode</u>	<u>Males</u>	<u>Females</u>
Walk	37.3	39.2
Bus	22.3	32.7
Car	40.4	28.1

---

Because females tend to have poorer mobility than males one would expect them to display a more limited spatial choice than males. And this is the case (Table 7.6). In addition to travelling shorter distances females also take longer to reach their dentist. This is undoubtedly part of the 'cost' females must bear for using the modes of travel they do.

Table 7.6

The mean distance and rank of surgeries attended by respondents of each sex, and the mean travel times incurred by them.

	<u>Males</u>	<u>Females</u>
Distance	2.7 Km.	2.3 Km.
Rank	23.9	22.3
Travel time	19.9 min.	21.1 min

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There is also a significant relationship between sex and mode of travel (Table 7.7), though it is relatively weak. However this disappears when the relationship is controlled by the ability to drive, and implies that the ability to drive is associated with the imbalance between the sexes in the modes of travel used.

Table 7.7

The relationship between sex and mode of travel.

CHI SQUARE = 34.72 SIG = 0.0000 CRAMER'S V = 0.14

Controlling for the ability to drive:

Can drive: CHI SQUARE = 3.4 SIG = 0.182

Cannot drive: CHI SQUARE = 3.78 SIG = 0.151

(The level of significance indicates the proportionate number of times that a chi square value of the given size could have occurred by chance. Cramer's V is a measure of the amount of co-variation in the two variables.)

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When the relationship between sex and mode of travel is controlled by car ownership a significant relationship exists only for those households owning one car (Table 7.8). In this situation it will generally be the husband who uses the car for his journey to work. Many more males from households owning one car travel by car than do females (Table 7.9).

Table 7.8

The relationship between sex and mode of travel, controlling for car ownership.

0 cars: CHI SQUARE = 4.45 SIG = 0.11

1 car: CHI SQUARE = 28.81 SIG = 0.0000 CRAMER'S V = 0.19

2 cars: CHI SQUARE = 1.93 SIG = 0.38

3 cars: CHI SQUARE = 2.70 SIG = 0.26

4 and 5: insufficient cases.

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Though there is a significant relationship between sex and mode for respondents from one car households, and though there is a significant relationship overall, these are not strong relationships. It is no surprise, then, that though there is a small difference in the distances travelled by males and females it is not statistically

significant. However, when controlled for mode of travel a significant difference does appear for patients who walk (Table 7.10). The main distinction being that relatively more females travel shorter distances than males. Thus, females who walk tend to exercise a more limited spatial choice than males who walk.

Table 7.9

The percentage of males and females from households owning one car who use each mode of travel.

<u>Mode</u>	<u>Males</u>	<u>Females</u>
Walk	27.2	34.5
Bus	15.8	27.1
Car	57.0	23.7

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Table 7.10

The relationship between sex and distance travelled.

CHI SQUARE = 12.07 SIG = 0.176

Controlling for mode:

WALK	CHI SQUARE = 20.14	SIG = 0.017	CRAMER'S V = 0.18
BUS	CHI SQUARE = 5.30	SIG = 0.81	
CAR	CHI SQUARE = 3.20	SIG = 0.96	

The percentage of those males and females that walk who travel different distances to their dentist.

<u>Distance</u> <u>Band</u>	<u>Males</u>	<u>Females</u>
0.0 - 0.5 Km	38.3	52.2
0.5 - 1.0 Km	34.4	28.1
1.0 - 1.5 Km	17.2	14.4
1.5 - 2.0 Km	4.8	3.7
2.0 - 2.5 Km	2.9	0.5
2.5 - 3.0 Km	1.0	0.0
3.0 - 3.5 Km	0.5	0.3
3.5 - 4.0 Km	0.5	0.0
4.0 - 4.5 Km	0.0	0.3
4.5 - 5.0 Km	0.5	0.5

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For the sexes, then, mode of travel does confer various costs and

benefits, generally favouring males. This is especially true for respondents from households owning one car. However, there is an indication that females do exercise a more limited spatial choice of dentist than do males. At least this would seem to be the case for respondents who walk.

### Socioeconomic category

One would expect there to be a relationship between SEC and mode of travel used, basically because car ownership is related to social class. Only, 17.2 per cent of SEC1 claimed not to own a car, (Table 7.11) in marked contrast to SEC4, where the majority of respondents (54.5%) were from households without a car. Conversely the majority of SEC1 (54.2%) were from households owning one car, as compared with only 37.9 per cent of SEC4.

Table 7.11

The association between SEC and car ownership.

<u>Cars</u>	<u>SEC1</u> %	<u>SEC2</u> %	<u>SEC3</u> %	<u>SEC4</u> %
0	17.2	40.5	42.2	54.5
1	54.2	48.4	46.8	37.9
2	25.5	9.9	8.4	7.6
3	3.2	1.2	2.7	0.0

CHI SQUARE = 140.48 SIG = 0.0000 CRAMER'S V = 0.1796  
(Chi square calculations based on raw totals, not percentages)

The distribution of 'ability to drive' mirrors that of car ownership (Table 7.12). There is a clear gradation from 76 per cent of respondents in SEC1 with driving licences to only 36 per cent in SEC4. Over 27 per cent of the variation in 'ability to drive' is associated with variation in the SEC of respondents.

Given the patterns of car ownership and ability to drive, the distribution of SEC by mode of travel comes as no surprise (Table 7.13). The majority of patients in SEC1 travel by car (52.2%), whereas the largest groups of patients in SECs 3 and 4 walk (49.6% and 49.5% respectively). Variation in the SEC of respondents is associated with more than 19 per cent of the variation in mode of travel.

Table 7.12

The percentage of each SEC with a driving licence.

<u>SEC1</u>	<u>SEC2</u>	<u>SEC3</u>	<u>SEC4</u>
75.9	56.2	46.3	36.4
CHI SQUARE = 98.23   SIG = 0.0000   CRAMER'S V = 0.271			

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Table 7.13

The percentage of each SEC using each mode of transport.

	<u>SEC1</u>	<u>SEC2</u>	<u>SEC3</u>	<u>SEC4</u>
Walk	29.4	34.0	49.6	49.5
Bus	18.4	31.9	25.2	34.8
Car	52.2	34.1	25.2	15.7
CHI SQUARE = 110.66   SIG = 0.0000   CRAMER'S V = 0.195				

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Taking "spatial choice" to mean the distance travelled, on average, by a subgroup of patients to obtain dental care, one can see that the spatial choice of each SEC reflects the varying proportions of the modes of travel used (Table 7.14). Generally, because the percentage who walk increases with decreasing social status, the average extent of spatial choice decreases with social status. The only exception being that patients in SEC2 travel slightly further than patients in SEC1.



Table 7.14

The average distances travelled by each SEC.

	<u>SEC1</u>	<u>SEC2</u>	<u>SEC3</u>	<u>SEC4</u>
Kilometres	2.7	2.8	2.0	2.0
Rank	27.9	27.5	16.0	15.1

---

Hence, SEC is an important factor in the distribution of costs and benefits. The 'higher' a patient's social status the less likely he is to walk, and the more likely to travel by car and exercise a relatively wide spatial choice.

However, as with the sexes, there is much reduced variation in the distances travelled between the SECs when mode is taken into account (Table 7.15). In other words, patients using the same modes of travel tend to exercise similar amounts of spatial choice. Clearly, much of the variation between the SECs can be accounted for by differences in the modes of travel they use, with the exception of bus to some extent (see Table 7.17).

Though the relationship between SEC and spatial choice is significant (Table 7.16) it is relatively weak. When controlled for car ownership, significant relationships are found only for respondents from households with no cars or one car, though these are the largest groups. The pattern of this relationship is for relatively more patients of 'low' social status to travel short distances and relatively more 'high' status patients to travel longer distances.

Table 7.15

The average distances travelled by patients in each SEC using each mode.

	<u>SEC1</u>	<u>SEC2</u>	<u>SEC3</u>	<u>SEC4</u>
Walk Distance	0.8	0.7	0.7	0.6
Rank	7.8	5.6	4.2	3.2
Bus Distance	3.4	3.3	3.0	3.3
Rank	39.2	39.9	29.9	30.6
Car Distance	3.5	4.2	4.0	3.6
Rank	35.3	36.8	30.6	22.9

Similarly, in terms of mode of travel (Table 7.17), there is a significant relationship between SEC and spatial choice only for respondents who travel by bus, as suggested earlier. Finally, controlling for the ability to drive would seem to largely remove differences in spatial choice between the SEC's (Table 7.18). Variation in spatial choice is apparent only for those who cannot drive.

Table 7.16

The association between SEC and spatial choice, controlling for car ownership.

CHI SQUARE = 85.48 SIG = 0.0000 CRAMER'S V = 0.1499

Controlling for car ownership:

0 Cars CHI SQUARE = 50.10 SIG = 0.0044 CRAMER'S V = 0.191  
 1 Car CHI SQUARE = 43.67 SIG = 0.0224 CRAMER'S V = 0.155  
 2 Cars CHI SQUARE = 27.95 SIG = 0.4136  
 3 Cars + Insufficient cases

Thus it would appear that there is a tendency for spatial choice to decrease as 'social status' decreases. However, this trend is removed where adequate 'mobility' is present, ie. ownership of two or more cars, and the ability to drive. For some reason, travel by bus does

not overcome differences in spatial choice between the SECs. A possible explanation for this is that some bus users of 'higher social status' might normally travel by car, but on this occasion for whatever reason they travelled by bus to their same choice of dentist.

Table 7.17

The relationship between SEC and spatial choice, controlling for mode of travel.

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Walk:	CHI SQUARE = 33.43	SIG = 0.183	
Bus:	CHI SQUARE = 45.34	SIG = 0.015	CRAMER'S V = 0.210
Car:	CHI SQUARE = 29.59	SIG = 0.333	

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Table 7.18

The relationship between SEC and spatial choice when controlling for ability to drive.

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Can drive:	CHI SQUARE = 30.77	SIG = 0.281	
Cannot drive:	CHI SQUARE = 57.88	SIG = 0.0005	CRAMER'S V = 0.199

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### Age

An analysis by age is included because one would expect age to be related to mobility in a number of ways, but particularly in terms of the minimum age requirement for drivers, the earning potential of different age-groups, and the expense of children during the child rearing ages.

Age is significantly associated with mode of travel (Table 7.19).

Walking is the most common mode for the younger age-groups (0 to 15), whereas travel by car is most popular for those aged 35 to 64.

Table 7.19

The percentage of each age-group using each mode of travel.

	0 to 10							
	:	11 to 15						
	:	:	16 to 20					
	:	:	:	21 to 34				
	:	:	:	:	35 to 44			
	:	:	:	:	:	45 to 54		
	:	:	:	:	:	:	55 to 64	
	:	:	:	:	:	:	:	64 plus
	:	:	:	:	:	:	:	:
Walk	61.3	62.5	41.6	37.5	33.1	33.2	32.1	33.6
Bus	17.5	28.4	44.1	28.2	19.5	24.4	25.9	41.6
Car	21.3	9.1	14.3	34.3	47.4	42.4	42.0	24.8

CHI SQUARE = 141.3    SIG = 0.0000    CRAMER'S V = 0.200

Approximately twenty per cent of the variation in mode of travel is associated with variation in age. This was expected because age is obviously a critical factor in predicting whether a person can drive and whether they can own a car (Tables 7.20 and 7.21).

Most respondents aged 21 to 64 are from households owning one car and most of them can drive. The majority of those aged twenty or less are from non car-owning households.

Whilst age is important, particularly from a legal point of view and in terms of learning to drive, it is probable that other factors, concerned with respondents stage in their life-cycle, are also exerting an influence. For example, young children will tend to have young parents. The early stage of child-rearing can, for young couples, be very expensive . Income at this time is generally relatively low, whilst financial demands - mortgage, children's clothes - can be high. It is not surprising that the absence of car-ownership in the household was fairly common for those aged ten or

Table 7.20

The distribution of car-ownership by age-group - percentages.

	0 to 10							
	:	11 to 15						
	:	:	16 to 20					
	:	:	:	21 to 34				
	:	:	:	:	35 to 44			
	:	:	:	:	:	45 to 54		
	:	:	:	:	:	:	55 to 64	
	:	:	:	:	:	:	:	64 plus
	:	:	:	:	:	:	:	:
0 cars	52.5	37.5	45.8	42.1	25.9	27.3	33.9	58.4
1 car	40.0	50.0	37.0	46.8	56.8	49.8	47.3	38.9
2 cars +	7.5	12.5	17.2	11.1	17.3	22.9	18.8	2.7

CHI SQUARE = 86.0 SIG = 0.000 CRAMER'S V = 0.156

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Table 7.21

The percentage of each agegroup claiming to have a driving licence.

	0 to 10							
	:	11 to 15						
	:	:	16 to 20					
	:	:	:	21 to 34				
	:	:	:	:	35 to 44			
	:	:	:	:	:	45 to 54		
	:	:	:	:	:	:	55 to 64	
	:	:	:	:	:	:	:	64 plus
	:	:	:	:	:	:	:	:
	3.1	0.0	32.7	62.8	69.9	66.0	63.3	47.9

CHI SQUARE=249.4 SIG=0.0000 CRAMER'S V=0.394

---

NB The percentage of those aged 0 to 10 who hold a driving licence is clearly a reflection of the ability to drive of the parents or guardians of those children.

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less and those between 16 and 20. Financial restriction is also important for the retired. This age-group also has many people without cars.

Following the distribution of modes of travel, the spatial choices

exercised by each age-group are also as might be expected (Table 7.22). Younger respondents tend to travel shorter distances, on average, and the car using age-groups travel longer distances. One paradoxical result is that the greatest average distance is travelled by those aged 21 to 34, although the majority of this age-group walk. The explanation is that car users in this age-group travel very long average distances (an average of 7.8 Km.). A further explanation of this result is suggested in the discussion of patient loyalty (Chapter Nine).

Table 7.22

The average distances travelled by respondents in each age group.

	0 to 10							
:	11 to 15							
:	:	16 to 20						
:	:	:	21 to 34					
:	:	:	:	35 to 44				
:	:	:	:	:	45 to 54			
:	:	:	:	:	:	55 to 64		
:	:	:	:	:	:	:	64 plus	
:	:	:	:	:	:	:	:	:
	2.5	1.6	2.9	4.1	3.8	3.4	2.8	2.0

Controlling by mode:

Walk	1.7	0.7	1.1	1.4	0.9	0.7	0.8	0.6
Bus	4.2	3.0	4.0	3.4	4.8	4.6	3.1	2.5
Car	3.4	2.7	4.9	7.8	5.4	4.8	4.3	2.9

---

Hence, age is important in distributing the costs and benefits of "mobility". The young and retired come off worst. They have poor access to private transport and are consequently able to exercise only a relatively limited spatial choice, or bear the higher cost of travel from living further afield. Stage in the life cycle could well be an important aspect of the distribution of costs and benefits, because of the imbalance between financial commitment and income.

## Conclusions

Overall, the evidence suggests a clear relationship between "mobility" and spatial choice. Much of the variation in spatial choice between the agegroups appeared to be related to variations in mode of travel used. This in turn was related to the ability to drive and car ownership. Apart from legal considerations related to age, the stage in th life cycle seemed to exert some financial restraint on access to private transport for the young and old.

There was a significant relationship with spatial choice for both sex and SEC. Interestingly, these relationships tended to disappear when mode of travel was controlled for. That is, patients using the same modes of travel tended to make similar spatial choices. Thus the original statistical relationship with spatial choice is due to the mode of travel used.

At this point car ownership and, to a lesser extent, the ability to drive become very meaningful. With SEC there was a clear relationship with car ownership: as social status "declined" so too did car ownership. On the other hand the proportions of each SEC that walked and travelled by bus increased as status declined. Hence it appears that car ownership is, perhaps, the most important determinant of spatial choice. And this, in turn, probably reflects the income of respondents in each SEC.

Relatively, more males travelled by car whilst more females travelled by bus or walked. There was a slight variation between the sexes in car ownership though not sufficient to account for the difference in

modes used. An alternative explanation for this difference was proposed, based on the number of cars owned. In households with only one car it is most likely that the husband will use it for his journey to work. Wives left at home, though from a car owning household, must clearly either walk or travel by bus. It was shown that where respondents were from households with no cars or with two or more, there was no significant difference in the spatial choices of males and females.

Thus, though "mobility" is associated with spatial choice the underlying mechanism distributing the costs and benefits of "mobility" seems to reflect stage in the life cycle, income and number of cars owned; and these themselves seem to be variations about a single theme. It is income that is the important variant with stage in the life cycle, and it is income that permits more cars to be bought. Thus, higher incomes would seem to allow people to buy themselves better mobility and the means to exercise a wider spatial choice in dental care.



## Chapter Eight

### Origins and Destinations

There are various types of study that consider or use the relationship between distance and behaviour. Location-allocation models use distance as the major influence on facility location or boundary position, generally on the assumption that people use their nearest facility. Distance is seen as being a major influence on the consumer's choice of shopping centre. In central place theory consumers are hypothesised to go to the nearest centre supplying the type of good they require. Invariably, the measure of distance used is that between a person's home and the facility in question.

However repeated use of this measure of distance implies that human beings make only single purpose trips that always begin and end at home. From our own personal experience we know that this is not always the case. We often try to accomplish several objectives in succession on any one trip, this being the most economic use of our time, money and transport resources. Behavioural geographers have recognised this and therefore adopted the concepts of bounded rationality, multiple goals and satisficing. In abstract terms these concepts tell us that individuals may not know the nearest facility of a particular kind and could not therefore choose to go there. Even if a person is aware of the nearest facilities of varying types when he has several requirements to satisfy during one trip it may make more sense to use a set of facilities more closely related to each other than to his home. Thus, for example, a shopping trip may extend along a major shopping throughfare away from the person's home and ignore alternative centres that are closer to his home but more distant from each other. If this shopping trip itself originates at a person's place of work, the distance from his home location may

have no influence on his choice of shops. This is most true for "lunch hour" shopping. However, shopping on the way home may tend to pick a location intermediate between home and work.

With this in mind it is the purpose of this chapter to consider how valid it is, at least for the study of trips to the dentist, to relate a patient's choice of dentist to his home location and to discover how important alternative types of origin and destination are. The extended tails of the distance decay curves in the previous chapter are clearly evidence that people do not always attend the nearest dentist to their home, perhaps because alternative locations are more important. Given the notions of multiple goals and satisficing it is clear that both origins and destinations must be considered. Where a person is going to may be just as important in his choice of dentist, or any other facility, as where he is coming from. Thus, the present focus of attention is the meeting ground of action space studies, location - allocation modelling, and consumer studies.

#### Alternative locations

The pilot surveys for testing the questionnaire were used also to identify the various alternative origins and destinations made use of by patients in Edinburgh. Besides the home location three other origin/destination types were shown to be important. These were work, shopping and school. Whilst there were others, such as visiting a friend, or going to the cinema these were not frequent enough to warrant an individual category in their own right and were thus lumped together in a category called 'elsewhere'. In the final

form of the questionnaire, fixed-response questions using these categories were used to collect the information on origins and destinations.

The address of the origin and destination was also requested. During the coding of the data these addresses were allocated to a postcode thus allowing enumeration district grid references to be identified from a cross-reference table supplied by the General Register Office. These allow a somewhat crude consideration of the distances travelled by patients to and from the dentist.

In the rest of this chapter the origins and destinations of journeys to the dentist by questionnaire respondents will first be described and then their interrelationships considered.

### Origins and Destinations

At the aggregate level (Tables 8.1 and 8.2,) it is plain that 'home' is the most important type of origin and destination, accounting for over 52 per cent of both. This finding may, at first sight, appear to support the use of the 'home' location in location-allocation studies. On the other hand it does show that nearly half of all origins and destinations involve locations other than home. It thus seems that location-allocation studies should consider a wider range of locations than just 'home'.

'Work' is the second most important type of location, accounting for 30 per cent of origins and 24 per cent of destinations. Its importance probably results from the fact that dentists work the

'normal' range of daytime working hours, and from the concentration of dental surgeries in the city centre where much of Edinburgh's employment is found. Thus it makes sense for people working in the city centre to attend a centrally located dentist. Even in the suburbs, dental surgeries tend to be situated in or close to local centres, where many people may work in offices and shops.

Table 8.1  
Frequency distribution of Origins

<u>Home</u>	<u>Work</u>	<u>Shopping</u>	<u>School</u>	<u>Elsewhere</u>
951	555	74	147	76
52.7%	30.8%	4.1%	8.2%	4.2%

---

Table 8.2  
Frequency distribution of Destinations

<u>Home</u>	<u>Work</u>	<u>Shopping</u>	<u>School</u>	<u>Elsewhere</u>
940	439	268	40	116
52.1%	24.3%	14.9%	2.2%	6.4%

---

The remaining location types - shopping, school and elsewhere - are less significant. This probably reflects the sizes of the appropriate population sub-groups. One cannot attend from school if one is not a school child.

Unlike the home location, work, shopping and school are not used equally as both origin and destination. The work and school locations are used more as origins than destinations, whereas the opposite is true for shopping. This suggests a 'flow' of patients from work and school and then on to somewhere else, probably home,

and from somewhere else and on to shopping. Table 8.3 presents the proportion of patients coming from each type of origin who then go on to each type of destination (row percentages) and the proportion of patients going to each type of destination who have come from each type of origin (column percentages). Generally three types of 'movement behaviour' may be discerned.

- 1) Homeward behaviour. No matter where patients originate the home location is the dominant destination (Table 8.3 row percentages). Excluding patients whose origin was home, 'homeward' behaviour suggests that many patients make their dental attendance the last 'task' in a string of daily activities. Many of these patients have come from work or school possibly after these activities have finished.
- 2) Circulating behaviour. When viewed from the destination perspective (Table 8.3 column percentages) 'home' is not the dominant origin for patients whose destination is work or school. Instead, patients whose destination is work, school or home tend to have come from the same type of origin, thus revealing a type of 'circulating' behaviour. Such behaviour suggests the dental surgery is conveniently located with regard to the patient's origin. This would seem to be very appropriate for patients coming from work. Many people live in the suburbs and work in the centre where there is a high concentration of dental surgeries. Clearly, it would be sensible for many of these people to attend a dentist from work rather than from home.

3) Shopping behaviour. There is an outflow of patients from home to shopping, via the dentist. Though this mode of behaviour is not very prominent numerically, an overwhelming majority of those whose destination is 'shopping' have originated from home. This appears to be the opposite of 'homeword<sup>a</sup> behaviour' in that for these patients, the dental attendance is the first in a series of activities.

Table 8.3

Cross-tabulation of Origins and Destinations.

<u>Origins</u>	<u>Destinations</u>				
	Home	Work	Shopping	School	Elsewhere
Home (Row %)	49.3	19.3	22.0	1.5	7.6
(Col %)	49.8	41.9	78.3	37.5	62.9
Work	46.4	44.5	5.7		3.2
	27.4	56.2	11.9		15.5
Shopping	79.7	4.0	13.5		2.7
	6.2	0.6	3.7		1.7
School	75.5		6.1	17.0	1.3
	11.8		3.3	62.5	1.7
Elsewhere	56.5	6.5	9.2		27.6
	4.5	1.1	2.6		18.1

Only four per cent of origins are accounted for by 'shopping' compared with 15 per cent of destinations. This is probably explained by the fairly unpredictable time requirements of shopping. Most dentists make use of an appointment system. When the time required for a shopping trip cannot be accurately determined it may be more convenient for the patient to go shopping after attending his dentist rather than run the risk of interrupting or cutting short the shopping trip. Other reasons may be that patients prefer to go home

after shopping, to avoid carrying heavy weight unnecessarily, or because shopping is a tiring activity.

These three types of behaviour include the vast majority of dental patients. For example, very few patients originate at work and go shopping, or vice versa. It thus seems that, with regard to strategies for 'stringing together' activities involving urban travel, the dental attendance is an event of some importance - being the first or last activity in a series of activities, or warranting a 'there and back' journey from a given activity.

#### Spatial perspective

A spatial perspective can be given to 'patient flows' by considering the geographic location of a patient's home and of the surgery he attends. The central/suburban dichotomy has already been used in this study and gives a general indication of geographic behaviour. Nomenclature for this section is based upon the following: patients are first categorised by their home location and then by their surgery location. Thus the classification suburban/central (hereafter abbreviated to S-C) means that a patient lives in the suburbs (i.e. more than 3 km. from the city centre) and attends a dentist in the centre.

There are four categories in this classification: C-C, C-S, S-C, S-S, and these have been cross-tabulated with origins (Table 8.4). From this one can see that relatively more patients who originate in the suburbs also originate from home than is true for patients whose origin is in the central area. This suggests that patients who live



in the suburbs are more likely to make the dental attendance their first activity on leaving home than are patients in the central area. Part of the explanation for this probably lies in the fact that alternative locations, such as work and shopping, are more scarce in the suburbs.

Table 8.4

Crosstabulation of Origins and SUBCEN<sup>1</sup>

<u>SUBCEN</u>	<u>Origins</u>				
	Home	Work	Shopping	School	Elsewhere
C-C (Row%)	48.4	37.7	3.8	6.2	3.6
(Col%)	28.9	38.7	29.3	24.1	27.6
C-S	46.5	36.0	1.1	3.4	12.7
	4.1	5.5	1.3	2.0	14.4
S-C	54.2	31.4	3.6	7.3	3.2
	27.7	27.6	24.0	24.1	21.0
S-S	56.1	23.4	5.1	11.1	4.2
	39.0	28.0	45.3	49.6	36.8

<sup>1</sup>SUBCEN= classification of origins and surgeries into either suburban or central.

For patients who attend from work (column 2 in Table 8.4) the outstanding feature is the sharp contrast between the relatively small proportion of suburban patients (28 per cent) compared with C-C patients (38.7 per cent). It is likely that the explanation for this supports that of the previous paragraph - there being relatively few work opportunities in the suburbs compared with the central area.

As an origin, shopping is relatively most popular for patients classified as S-S (45.3 per cent). Whilst this proportion is the largest, it is interesting that the proportion of S-C patients (24

per cent) is much smaller. It was argued above that shopping as an origin was relatively unimportant because of the problem of fixed appointment times at surgeries. Patients classified as suburban-central are probably more likely to be involved in 'major' shopping-trips, which themselves are more difficult to control in terms of the time required. This difficulty is a possible cause accounting for the relatively small proportion of shoppers categorised as S-C. The corollary to this is that S-S patients are probably engaged on only 'minor' shopping trips, which can more easily be accomplished before attending the dentist.

The very large proportion of patients attending from school who are classified S-S (49.7 per cent) probably reflects the relatively high proportion of school age children living in the suburbs.

When home destinations are considered (Table 8.5) there is a sharp contrast between the two suburban groups. Thus 42.7 per cent of S-S patients go home compared with only 22.2 per cent of the S-C patients. Suburban patients attending central surgeries are relatively unlikely to return home immediately afterwards.

Relatively high proportions of those going to work or shopping are S-C patients (32.1 per cent and 33.4 per cent respectively).

Clearly these patients attend central surgeries because they use other centrally situated facilities. Also, a relatively high proportion of patients going to work are classed as central-central. Thus work as a destination is popular amongst patients attending central surgeries, irrespective of where they live. This gives some

credence<sup>e</sup> to the notion that the work location can be an important determinant of a patient's choice of dentist.

Table 8.5

Crosstabulation of Destinations and SUBCEN

<u>SUBCEN</u>	<u>Destinations</u>				
	Home	Work	Shopping	School	Elsewhere
C-C (Row%)	50.4	27.3	13.3	1.9	7.0
(Col%)	30.4	35.5	28.2	27.5	33.8
C-S	50.0	22.0	16.2		11.6
	4.5	4.3	5.2		8.4
S-C	43.1	28.8	18.4	2.0	7.5
	22.2	32.1	33.4	25.0	31.3
S-S	60.7	18.4	13.3	2.8	4.6
	42.7	28	33.0	47.5	26.2

### The Role of Distance

Having established that non-home locations are important as origins and destinations, and that marked 'types' of movement-behaviour may be discerned, it becomes of interest to determine whether distance is a factor 'shaping' the flows, and particularly whether patients make spatially rational choices. First, the distances involved will be described; second, evidence will be sought for 'distance minimisation'. The distances used are those between the home and surgery, between the origin and surgery, between the surgery and destination, between home and origin, and between the origin and destination.

Home has been shown to be the dominant location, both as an origin

and destination. If spatial rationality is a factor in the choice of a patient's dentist it is to be expected that home will be fairly close to the surgery. There is an overall tendency for origins to be further from the surgery than are patient's homes (Table 8.6). The one exception to this is for 'shoppers' whose origins are generally closer to their dentist than is their home. Probably, this reflects the fact that dentists tend to locate in 'local' centres which are comprised mainly of shops.

Table 8.6

Mean home-surgery distance and origin-surgery distance for each type of Origin for the whole sample and for each spatial behaviour group.

		<u>Origins</u>					
		Home	Work	Shopping	School	Elsewhere	All
<u>ALL</u>							
	HDIST	2.12	2.34	2.21	1.79	2.53	2.18
	ODIST	2.12	2.35	1.99	1.94	2.28	2.46
-----							
C-C.	HDIST	1.29	1.56	1.67	1.09	1.76	
	ODIST	1.29	3.01	0.83	2.14	2.44	
C-S.	HDIST	3.28	3.20	2.11	3.60	3.26	
	ODIST	3.28	4.12	--	1.62	1.58	
S-C.	HDIST	3.94	3.94	4.57	3.83	4.58	
	ODIST	3.94	2.40	2.20	3.13	2.38	
S-S.	HDIST	1.32	1.69	1.31	1.07	1.65	
	ODIST	1.32	4.75	2.66	1.25	2.40	

HDIST= home - surgery distance  
ODIST= origin - surgery distance

---

In contrast, destinations are marginally closer to the surgery than are homes, and substantially closer than origins (Table 8.7).

However, at the aggregated level, only for 'shoppers' is the

Table 8.7

Mean home-surgery distance and surgery-destination distance for each type of Destination, for the whole sample and for each spatial behaviour category.

		<u>Destinations</u>				
		Home	Work	Shopping	School	Elsewhere
<u>ALL</u>						All
	DDIST	1.81	2.70	2.52	1.41	2.62
	DDIST	1.81	3.04	1.98	2.34	2.15
-----						
C-C	HDIST	2.23	4.67	4.17	-	3.64
	DDIST	2.23	4.36	4.49	-	0.75
C-S	HDIST	1.26	1.66	1.34	1.27	1.73
	DDIST	1.26	2.59	1.34	3.91	1.97
S-C	HDIST	3.66	4.29	4.10	2.67	4.50
	DDIST	3.66	2.58	2.37	2.62	2.87
S-S	HDIST	1.20	1.91	1.68	0.84	1.22
	DDIST	1.20	4.05	1.86	0.87	3.05

HDIST= home - surgery distance  
DDIST= surgery - destination distance

destination markedly closer than home. This, almost certainly, is accounted for by S-C patients 'using' central shops.

That non-home locations should influence a patient's choice of dentist seems a perfectly reasonable concept, especially when 'circulating' behaviour is involved. However it appears that the distance between a patient's home and non-home location may also be important. For S-C patients the origin-surgery distance is much smaller than the home-surgery distance. This suggests that their choice of dentist is influenced by where they work. Further support for this is found when destinations are considered. For S-C and C-C patients going on to work, the surgery-destination distance is less than the home-surgery distance. These patients are attending dentists

much further from home than those in the two other categories. It would, then appear that some patients who are rather far from their homes during the day seem to choose their dentist with reference to this location rather than their home. Further evidence concerning this point (Table 8.8) is not clear-cut. There are certainly strong and positive correlations between home-origin distance and home-surgery distance (for all patients not attending from home). Thus, the further the origin from home the further the surgery is from home. However, the above hypothesis would suggest that as the distance between the patient's origin and home increases the distance between origin and surgery should decrease. This does not seem to be the case. There is a strong and positive correlation between home-origin distance and origin-surgery distance suggesting that patients whose origin is far from home are willing to travel relatively long distances to their dentist. They appear to use the distance from home as a cue to exercise a wider 'spatial choice' for dental care than they might if the origin had been close to their home.

Table 8.8

Correlations showing the strength of association between the home-origin distance and: the home-surgery distance, the origin-destination distance and the surgery-destination distance, for patients attending from non-home locations.

	<u>Work</u>	<u>Shopping</u>	<u>School</u>	<u>Elsewhere</u>	<u>All</u>
HODIST-HDIST	.146*	.670**	.467**	.382**	.205**
HODIST-ODIST.	.909*	.601**	.518**	.709**	.884**
HODIST-DDIST	.150*	.438*	.602**	.165	.187**

\* = significant at 0.05 level;  
 \*\* = significant at 0.01 level.

HODIST= home-origin distance;  
 HDIST = home-surgery distance;  
 ODIST = origin-surgery distance;  
 DDIST = surgery-destination distance.

---

### Minimising the distance travelled

The presence of 'distance minimising' behaviour is evidence that people use 'space' in a rational manner. A distance minimisation strategy would result in patients using their dentists's surgery spatially - as a staging post, to break a long journey into two short ones.

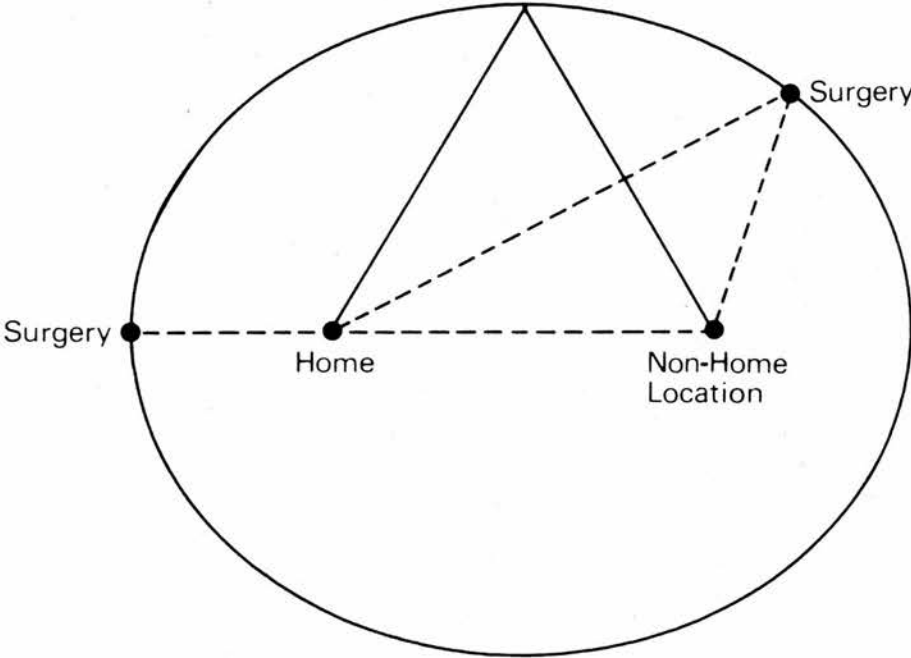
It is possible to summarize, on a geometric basis, the distance relationship between each patients' home, surgery and non-surgery locations in the following manner. If the distance between home and surgery and between surgery and non-home locations are summed and then divided by the distance between home and non-home locations it is possible to obtain a crude measure of the extra distance which the patient has travelled to attend his dentist (Figure 8.1). For example, if the resulting ratio value is 1 this would signify no deviation. The home, surgery and non-home location lie along a straight line (Figure 8.1a). A value of 2 would indicate that the surgery lies on the equi-deviational ellipse (Figure 8.1b). The distance from home to any point on the ellipse and then on to the non-home location is twice that between home and non-home location directly. Should the surgery be located within the ellipse the ratio value would be between 1 and 2. Here, the surgery is closer to either the home or non-home location, though not necessarily both, than they are to each other. In this situation patients appear to be exercising a certain amount of distance minimisation, especially if both home-surgery distance and surgery-destination distance are shorter than the origin-destination distance. On the other hand,

Figure 8.1 TRAVEL DEVIATION AND DISTANCE MINIMISATION

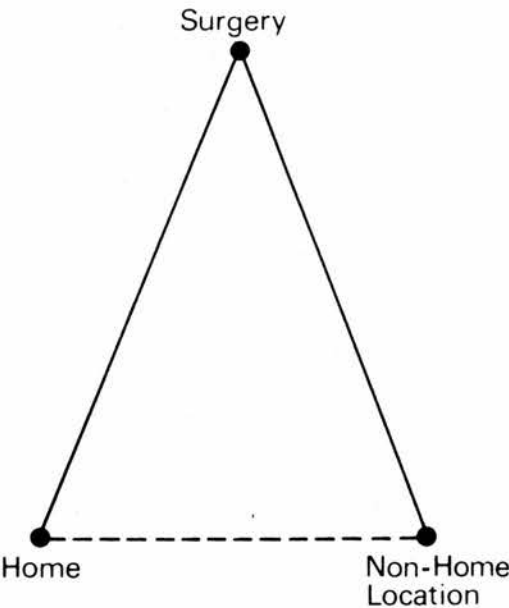
(a) No deviation - pure distance minimisation



(b) Equi-deviational ellipse



(c) No distance minimisation





values greater than 2 (Figure 8.1c) signify little attempt at distance minimisation. In this case the surgery lies outside the equi-deviational ellipse.

It is, therefore possible to allocate patients to one of three categories:

- 1) 'minimising', i.e. both origin-surgery distance and surgery-destination distance are shorter than the origin-destination distance - the true distance 'minimiser', (ratio  $< 2$ ):
- 2) 'reducing', i.e. overall distance is kept relatively short, though either the origin-surgery distance or surgery-destination distance is greater than origin-destination distance, (ratio  $< 2$ );
- 3) 'not reducing', i.e. both origin-surgery distance and surgery-destination distance are larger than origin-destination distance, - little attempt at reducing distance (ratio  $> 2$ ).

Only 31.2 per cent (570) of the sample could be allocated to one of these groups - the rest were disqualified either because both or neither of their origins and destinations were home (42.3 per cent) and were thus not suited to this analysis, or because they did not complete their questionnaire as fully as required. Of those who were eligible (Table 8.9) 42.6 per cent were designated as 'minimising', 31.6 per cent as 'reducing' and 25.8 per cent as 'not reducing'. 'Minimisers' comprise the largest group and those 'not reducing' are the smallest. On this basis it seems that the majority of patients display rational behaviour in that they try to keep down the distances they travel.

Table 8.9

The distribution of dental patients between 'minimising', 'reducing' and 'not reducing' categories.

	<u>N</u>	<u>%</u>
Minimising	243	42.6
Reducing	180	31.6
Not reducing	147	25.8

---

A note of caution must be introduced here. It seems reasonable to assume that patients travelling the shortest distance between origin and destination would be least concerned about the length of each stage of the journey. The greater the distance between origin and destination the more pressing is the need to 'minimise' actual distance travelled. Nevertheless, if the geometry of patients' journeys is a valid measure of the extent that patients try to minimise the distances they travel, it is to be expected that the actual distances travelled would reflect this. This does appear to be borne out by the survey (Table 8.10) in that the group categorised as minimising exhibits the shortest average total distance (5.29 Km). Thus the 'behavioural geometry' of patients' journeys does identify a group, categorised as 'minimising', who do actually travel the shortest average distance even though theirs is the largest average distance between origin and destination (5.29 Km). In a sense this is an odd result. One would have expected 'minimisers' to display the greatest average distance travelled because theirs is the greatest average distance between origin and destination. An explanation could be that 'minimisers' are consciously aware of the distances involved and really do try to minimise the distance they travel. As a characterisation, 'distance minimising' does seem appropriate for this group.

Table 8.10

Comparison of the mean actual distances travelled by patients in each of the 'minimising', 'reducing' and 'not reducing' categories with the corresponding mean distance between their origins and destinations. Distances are measured in kilometres.

	<u>Actual distance</u>	<u>Origin-destination distance</u>
Minimising	5.3	4.9
Reducing	5.8	4.3
Not reducing	5.5	1.5

---

### Conclusion

Three important points emerge from this chapter. First, though the home location is dominant nearly fifty per cent of origins and destinations are non-home. This shows that use of only the home location in location-allocation studies is not an accurate reflection of reality.

Secondly, three types of movement behaviour or 'flow' of patients were discerned homeward bound, circulating and shopping. If these are characteristic of urban movement generally, then much research is required on precisely how people make use of urban space.

Incorporation of such behaviour into location and spatial interaction models will enable them to be applied more effectively to urban problems.

Finally, the available evidence does suggest that some effort is made by some dental patients to minimise, in some way, the distance they travel. This implies that they are spatially aware and organise their trips so as to make effective use of the facilities they frequent. In

other words they behave in a manner that suggests they make spatially rational decisions. If this conclusion is applicable generally to other activities, it does offer hope that a theory of spatial behaviour may eventually be developed.

## Chapter Nine

### Patient Loyalty

A patient's loyalty to his dentist may be one of the reasons why some patients travel longer distances than they need. It may also be an important consideration for a dentist about to establish a new surgery. If the population within the area in which the new surgery is to be located will tend to remain loyal to their current dentists then there is little chance of success for the new surgery.

Almost certainly the major factor behind patient loyalty is satisfaction with one's treatment. Other factors are not easy to discern. The concept itself relates to a patient continuing to attend his dentist when either he or his dentist moves away, causing longer journeys. Thus, there are two aspects to patient loyalty: the geographical, and the continuance of this behaviour through time. This chapter is concerned with ascertaining whether patient loyalty exists; and what light it throws on the spatial behaviour of patients.

Phillips (1979) has shown in West Glamorgan that the area of previous residence can influence a person's choice of GP. He found that shorter distance moves could allow the previous GP to be retained, but that longer distance moves were usually associated with a change of GP, because the distance was too great to permit continued treatment by the previous doctor.

A patient may be deemed loyal if he keeps the same dentist either when he moves home to a location away from his dentist, or when his dentist moves away. For this study only loyalty by patients who moved away from their dentist was examined. Thus, in order to display loyalty a patient must have been attending the same dentist for a

longer period than he has lived at his present address, which in turn must be further away from his dentist than his previous address. A study of loyalty when the dentist moves away would require other data and a different survey methodology than the one adopted here.

The discussion of patient loyalty first identifies patients who are temporally loyal - that is, they continue to attend the same dentist for more than one course of treatment - and then introduces the geographic element that forms the focus of this chapter.

Interrelationships between time and space are then considered.

Finally, differentials between socio-economic groups are assessed.

#### Temporal Loyalty

Respondents to the questionnaire survey were asked the following questions:

- a) How long is it since you first came to this dentist?
  - 1) less than one year
  - 2) between one and two years
  - 3) between two and five years
  - 4) over five years
- b) For how many years have you lived at your present address?
- c) What was your previous address?

Their responses were used in considering the effect of patient loyalty on spatial behaviour.

The distribution of temporal loyalty (Table 9.1) is bi-modal, with identical proportions of respondents having attended their dentist

for either less than one year or for over five years.

Table 9.1

Temporal loyalty

	<u>N</u>	<u>%</u>
0-1 Year	570	32.5
1-2 Years	225	12.8
2-5 Years	388	22.1
6 Years +	569	32.5

---

Patients who have attended their dentist for over one year are obviously displaying a certain amount of temporal loyalty, whilst those who are attending their choice of dentist for the first time will be amongst the 'less than one year' group. This latter group will comprise those who do not display loyalty to any dentist and attend a different one for each course of treatment, and also those who are changing dentist for any one of a number of possible reasons: for example, dissatisfaction with a former dentist; their former dentist moving away; being new residents to Edinburgh. This category also includes those who are attending the same dentist for a second time within one year. It is therefore clear that a considerable proportion of patients (at least 67.5%) display a degree of temporal loyalty.

To a certain extent the period of temporal loyalty appears to be associated with the pattern of attendance (Table 9.2). More than half those who have been attending the same dentist for more than one year are regular attenders. Those who have attended the same dentist for less than one year show a high propensity to attend only when 'having trouble'. Thus, patients who see themselves as regular



attenders tend to have a long standing association with one particular dentist. This may reflect two notions, the first being that treatment received by the patient has been of sufficiently high quality not to deter him from making regular attendances. In turn, this may reflect genuine skill by the dentist, a high pain threshold on the part of the patient, innately good teeth requiring little attention from the dentist or a firm commitment by the patient to maintain his teeth by regular attendance. The second notion is that once a patient has found a dentist he likes he is unlikely to change to another of unknown quality. This, of course, relates to the earlier point concerning the skill of the dentist.

Table 9.2

Temporal loyalty and pattern of attendance: the percentage of patients in each category of temporal loyalty who attend regularly, occasionally and only when 'having trouble'.

	<u>Regular</u>	<u>Occasional</u>	<u>Trouble</u>	<u>Total</u>
0-1 Year	46.3	21.6	32.1	557
1-2 Years	54.0	29.5	16.5	224
2-5 Years	73.3	14.5	12.2	385
5 Years +	68.2	14.4	17.4	557

CHI-SQUARE = 114.3 DF=6 SIG=0.0000 CRAMER'S V=0.182

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One would expect those patients who are not regular attenders to be less concerned with having a stable relationship with one dentist simply because it affects them less. It would be less important for them to attend a dentist of known quality. In addition they may have a lower pain threshold, generally weaker teeth requiring a lot of treatment, or have experienced painful treatment in the past. All these factors would tend to deter patients from being regular

attenders.

Whilst these points are speculative in nature it is certainly true that temporal loyalty is associated with SEC (Table 9.3).

Respondents who have been loyal to the same dentist for two years or more are more likely to be in SECs 1 and 2 than in SECs 3 or 4.

Similarly respondents in SECs 1 and 2 are more likely to have attended the same dentist for two years or more than for less than two years. Conversely, respondents in SECs 3 and 4 are most likely to have attended their dentist for less than two years. Thus, the relationship between SEC and the propensity to be dental patients and between SEC and the pattern of attendance (Chapter 5) are seen also to have a temporal component. Higher social status patients are not only over representative of their corresponding population sub-group and more likely to be regular attenders, but are also more likely to have consistently attended the same dentist over an extended period of time than are patients of lower social status.

To a certain extent it is to be expected that temporal loyalty and age should be related, simply because older patients have lived longer and are likely to have lived at the same address for longer (Table 9.4). They have thus had more opportunity to attend the same dentist for a relatively long period of time. That such a relationship exists is, thus, no surprise (Table 9.5). However, it is interesting to note that in relative terms considerably more of those who have attended the same dentist for less than two years are aged between 16 to 34. This age-group are very mobile residentially (Table 9.4), and this may partly account for their prominence amongst

those patients who are not loyal. Another reason may simply be that these patients are more likely to attend a dentist only when having trouble and thus are less likely to remain with the same dentist (Table 9.6).

Table 9.3

Temporal loyalty and socio-economic category

		<u>SEC1</u>	<u>SEC2</u>	<u>SEC3</u>	<u>SEC4</u>	<u>Total</u>
0-1 Year	(Row %)	24.3	37.4	23.4	14.9	457
	(Col %)	27.0	29.4	41.3	35.4	
1-2 Years		23.3	39.1	19.0	18.4	184
		10.5	12.4	13.5	17.7	
2-5 Years		28.9	44.2	13.3	13.6	339
		23.8	25.8	17.4	24.0	
6 Years +		34.3	40.2	15.5	9.5	464
		38.7	32.5	27.8	22.9	
<hr/>						
Total		411	582	259	192	1444

CHI-SQUARE=35.4 DF=9 SIG=0.0001 CRAMER'S V=0.09

Table 9.4

Mean length of residence at present address for questionnaire respondents in each age group.

<u>Age Group</u>	<u>Mean</u>	<u>N</u>	<u>S.D.</u>
0-15	7.2	155	4.04
16-20	10.32	205	6.42
21-34	5.89	584	6.40
35-44	7.68	248	6.26
45-54	12.47	200	8.12
55+	17.12	214	12.57

#### Temporal loyalty and distance

Increased temporal loyalty is associated with longer distances between the patient's home and his dental surgery (Table 9.7). From one year onwards the mean distance shows an increase with temporal

Table 9.5

Temporal loyalty and age

<u>Temporal</u> <u>Loyalty</u>	<u>Age-groups</u>					
	<u>0-15</u>	<u>16-20</u>	<u>21-34</u>	<u>35-44</u>	<u>45-54</u>	<u>55+</u>
0-1 Yr (Row %)	8.9	12.8	45.3	11.9	9.3	11.7
(Col %)	31.3	31.7	38.8	25.4	25.7	30.4
1-2 Years	12.9	16.9	48.0	8.9	5.8	7.6
	17.8	16.5	16.2	7.5	6.3	7.7
2-5 Years	11.6	10.6	39.2	16.2	11.3	11.1
	27.6	17.8	22.9	23.5	21.4	19.5
6 Years +	6.7	13.7	25.8	20.6	16.9	16.3
	23.3	33.9	22.1	43.6	46.6	42.3
-----						
TOTAL	163	230	665	268	206	220

CHI-SQUARE=105.6 DF=15 SIG=0.0000 CRAMER'S V=0.142

Table 9.6

Pattern of attendance with age: the percentage of each age-group who attend regularly, occasionally or only when 'having trouble'.

<u>Type of</u> <u>Attender</u>	<u>Age-group</u>					
	<u>0-15</u>	<u>16-20</u>	<u>21-34</u>	<u>35-44</u>	<u>45-54</u>	<u>55+</u>
Regular	57.9	51.2	58.6	67.8	62.6	50.9
Occasnl.	17.9	26.0	20.3	14.2	18.7	15.3
Trouble	14.3	22.7	21.1	18.0	18.7	33.8
-----						
TOTAL	168	242	684	267	203	222

CHI-SQUARE=44.9 DF=10 SIG=0.0000 CRAMER'S V=0.112

loyalty. However, the mean distance for patients who have attended their dentist for less than one year is 2 Km., which is greater than that for the next category. This suggests two things.

First, patients who do not display temporal loyalty appear not to make the most spatially rational choices. If they did it might be

expected that the mean distance between their home and surgery would be similar to those who have been loyal for 1 to 2 years.

Table 9.7

The mean distance between home and surgery for questionnaire respondents in each category of temporal loyalty.

	<u>MEAN</u>	<u>N</u>	<u>S.D.</u>
0-1 Year	2.0	570	1.8
1-2 Years	1.8	225	1.8
2-5 Years	2.1	388	2.0
6 Years +	2.5	569	2.2

Secondly, because the mean distance between home and dentist increases with temporal loyalty, it would appear that the initiation of patient loyalty is, at least partly, dependent on the close proximity of the dentist's surgery to the patient's home. As the period of loyalty increases average home-surgery distances increase. This may be interpreted in the following manner. Most patients who display temporal loyalty tend to be regular attenders (Table 9.2). It would seem reasonable to assume that patients intending to be regular attenders will attach some importance to developing a stable association with one dentist, once they have found one with whom they are satisfied, regardless of distance.

Attending a dentist is an event associated with the possibility of pain in most people's minds, hence the maxim: 'better the devil you know than one you don't' would appear appropriate. Because attending the dentist regularly is of importance it is not unnatural that there should be a general tendency to spatial rationality by choosing a dentist relatively close to home. This would certainly be the

expectation based on theory (see Chapter 10). However, it is a fact of life that most people change their residential address at least once during their life. It is therefore not surprising that as the period of temporal loyalty increases so does the mean home-surgery distance (Table 9.7). Such measurements almost certainly reflect the fact that many respondents have moved away from their dentist yet continue to attend him.

An alternative factor influencing the distance between a patient's home and dentist is the reason why he chose his dentist in the first place. Patients were asked, "Why did you choose this dentist? Was it because this dentist is:

- 1) near your home
- 2) near your work
- 3) you were recommended to come here?"

A significant relationship exists between the reason for choice of dentist and temporal loyalty (Table 9.8). Relatively few of those patients who do not display loyalty chose their dentist because he was near their home, whilst relatively more chose him because he was either near their work or they were recommended to go to him. It therefore appears that for patients who are not temporally loyal it is less important that their choice of dentist be close to their home, and relatively more important that he be close to their workplace. This trend is supported by the fact that, of those who were recommended, patients not displaying loyalty were much more likely to have been recommended by a 'workmate' than are patients who do display loyalty (Table 9.9). This suggests that, for patients not

displaying loyalty, the choice of dentist is less likely to be made with reference to the home location than for other patients. In itself this supports the notion that it is less important to these patients for their dentist to be close to their home simply because they do not attend the same dentist. Thus, the lack of loyalty does not mean the shortest distances. It is associated with an apparent spatial irrationality, which in turn appears to be related to a rationale of choice which shows more reliance on the patient's place of work, either directly or through the recommendation of a workmate.

Table 9.8

Temporal loyalty and reason for choice of dentist

	<u>NR.home</u>	<u>NR.work</u>	<u>Recommended</u>	<u>Total</u>
0-1 Year (Row %)	32.2	8.4	59.4	544
1-2 Years	40.3	5.1	54.6	216
2-5 Years	39.1	5.4	55.4	368
6 Years +	41.7	3.7	54.6	542

CHI-SQUARE=19.6 DF=6 SIG=0.0032 CRAMER'S V=0.077

Table 9.9

Temporal loyalty and source of recommendation

	<u>Relative</u>	<u>Neighbour</u>	<u>Friend</u>	<u>Workmate</u>	<u>Total</u>
0-1 Year (Row %)	32.8	8.4	42.3	16.5	381
1-2 Years	16.8	7.0	69.7	6.6	244
2-5 Years	34.8	4.3	52.8	8.1	233
6 Years +	41.0	7.8	44.3	6.9	332

CHI-SQUARE=33.5 DF=9 SIG=0.0001 CRAMER'S V=0.101

So far the discussion has been based solely on temporal loyalty. However, for the present purpose it is desirable to consider loyalty

with a strong spatial element. It is possible to achieve this in two steps. The first relates temporal loyalty to the period of time the patient has lived at his present address. By such means three classes are formed:

- 1) patients who have been attending their dentist for longer than they have lived at their present address, ie. residentially loyal;
- 2) patients who have lived at their present address for longer than they have been attending their dentist ie. not residentially loyal;
- 3) patients who have attended their dentist for approximately the same time as they have lived at their present address, and for whom residential loyalty cannot be accurately determined.

Temporal loyalty is associated with the length of time a person has lived at his present address (Table 9.10). As temporal loyalty increases there is a tendency for the average period of residence to increase. This is largely what would be expected on the basis of spatial rationality, that when a person changes his address he also changes his dentist to one close to his new home. From Table 9.11 it can be seen that at least 15.8 per cent have not changed their dentist despite changing their address. If some patients do display spatial loyalty it is amongst this group that they will be found.



Table 9.10

The mean period of residence at the present address for respondents in each category of temporal loyalty.

	<u>MEAN</u>	<u>N</u>	<u>S.D.</u>
0-1 Year	7.8	472	7.8
1-2 Years	8.4	195	9.7
2-5 Years	8.2	355	7.6
6 Years +	11.4	529	8.6

---

Table 9.11

The distribution of residential loyalty.

	<u>N</u>	<u>%</u>
Loyal	245	15.8
Disloyal	707	45.6
Indeterminate	599	38.6

---

The second step in achieving a spatial measure of loyalty is to distinguish - for all respondents giving a previous address - between those who moved away from their present surgery and those who moved towards it. Clearly spatial loyalty - moving away and yet remaining with their former dentist - can be ascribed only to patients in the first group.

Because of non-response to the question of previous residence and because some respondents may not have had a previous residence or their previous residence was outside Edinburgh, the total number of respondents subjected to the cross-classification is substantially reduced (Table 9.12). Consequently, any accurate estimate of the proportion of patients who are spatially loyal is precluded.

Nonetheless, it is important to note two points. First, the fact that some patients are spatially loyal. Second, in any

Table 9.12

Residential loyalty and the direction of residential move, away or towards the dentist.

<u>Residential</u> <u>Loyalty</u>		<u>Away</u>	<u>Toward</u>	<u>Total</u>
Loyal	(Row %)	51.8	48.2	218
	(Tot %)	11.7	10.8	
Disloyal		29.1	70.9	409
		12.3	29.9	
Indeterminate		35.7	64.3	342
		12.6	22.7	
-----				
Total				969

classification based upon deduced classes it is possible for some classes to remain empty. However, in this case we see that approximately twelve per cent of the reduced pool of respondents have been identified as spatially loyal.

Although the major concern at present is with spatially loyal patients, it is appropriate at this point to recognise a number of issues that arise from Table 9.12. First, the consideration of spatial loyalty will proceed on the basis of the contrast between patients identified as spatially loyal and the remainder. Second, though some residentially loyal respondents were not classified as spatially loyal, simply because their residential move was towards their dentist rather than away, this is not to say that they are spatially disloyal. It is just that because they have not displayed spatial loyalty they cannot be classified as such. Quite possibly, if these patients had moved away from their dentist many would have remained spatially loyal. Third, it is of interest to note that some of the temporally disloyal patients moved away from their present dentist.

Of course these patients cannot be categorised as spatially loyal. However, the fact that these patients have chosen a dentist closer to their former home than to their present one does suggest an attachment, of some sort, to their former home area. This point will be considered again later.

It is not unreasonable to expect that spatially loyal patients, who have moved away from their dentist, will display considerably longer distances between home and surgery than other patients (Table 9.13). In other words it is not unreasonable to expect spatially loyal patients to constitute a larger proportion of those patients travelling beyond the median distance than those who travel less than this distance. This is in fact the case (Table 9.14). Spatially loyal patients comprise 19.5 per cent of patients travelling beyond the median distance but only 5.3 per cent of those who travel less than the median. Hence, it can be asserted that loyalty to a dentist does tend to cause patients to travel longer distances than they may otherwise need to.

Table 9.13

Mean distance between home and surgery for spatially loyal patients and the remainder.

	<u>MEAN</u>	<u>N</u>	<u>S.D.</u>
SP.Loyal	3.6	113	2.3
Remainder	2.0	856	1.9

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STUDENTS T=7.18      DF=968      SIG=0.0000

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Table 9.14

Spatial loyalty and distance between home and surgery.

	<u>LT.Median</u> <u>Dist.</u>	<u>GT.Median</u> <u>Dist.</u>
Sp.Loyal (Col %)	5.3	19.5
Remainder	94.7	80.5
<hr/>		
TOTAL	533	436

CHI-SQUARE=45.8 DF=1 SIG=0.0000 PHI=0.221

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Given the spatial nature of the concept of loyalty used in the present analysis the question naturally arises as to whether or not space - or in this case, distance - influences loyalty. More precisely, as distance from the surgery increases does the incidence of spatial loyalty decline? The answer to this question is yes (Table 9.15), but the decline with distance is no greater than for those who are not spatially loyal. Thus, distance does not appear to exert an influence on the decision of whether or not to be spatially loyal. To a certain extent this conclusion is probably dependent upon the method of operationalising the concept of spatial loyalty used in this study. Most importantly, only those respondents who moved within Edinburgh were considered in the analysis, thus limiting the maximum distance that patients could move from their dentist to the dimensions of the city. If the study had been conducted in a larger city it is possible that some patients may have moved distances sufficiently great to deter them from being loyal.

An equally important question is whether spatial loyalty persists with time after the patient moves. When a patient moves house he need not have a detailed understanding of his new home area. Consequently, it is probable that much of his spatial activity will

Table 9.15

Residential loyalty and length of the move away.

<u>Distance</u>	<u>Loyal</u>	<u>Disloyal</u>	<u>Loyal?</u>
0.1Km. (Col %)	45.1	49.6	44.3
1-2 Km.	21.2	17.6	20.5
2-3 Km.	15.9	16.8	14.7
3-4Km.	17.7	16.0	20.5
-----			
Total	113	119	122

CHI-SQUARE=1.7 DF=6 SIG=0.94

be based upon the knowledge he already has, i.e. of his former home area. For day to day requirements the new mover may well quickly become acquainted with his new home ground but for requirements of an infrequent nature he may not be affected by the circumstances of the new home area for some considerable time. Because of the relatively infrequent use of dental services it is less imperative that new, spatially rational, dental choices be made. As a result, old patterns may persist. However, as time continues more detail concerning the availability of dental care locally is likely to be acquired.

Also, the cost of remaining loyal to one's dentist becomes increasingly apparent as more journeys of a spatially inefficient type are made. Eventually there may come a time when a patient decides that a more spatially suitable dentist is required and available. Of course, such a decision could only be made after any feelings of 'better the devil you know than the one you don't' have been overcome.

Unfortunately, the data collected for this study are not ideally

suited to tackle this question, mainly because the information on the length of time each patient has been attending his dentist is nominal level data. From the earlier discussion it is clear that for patients who have lived at their present address for six years or more and have attended their present dentist for over five years it is impossible to determine whether or not they are residentially loyal. However, if these patients are ignored it is possible to gain some impression of how residential loyalty varies with time since the change of address. Residential loyalty decreases greatly as time increases (Table 9.16), whilst the numbers of residentially disloyal patients shows a relatively small decrease during the same period. Consequently, it does appear that residential loyalty has a temporal component, with the number remaining loyal declining as the time following a change of address increases. As might be expected this temporal component is also to be found amongst the spatially loyal (Table 9.17).

Table 9.16  
Residential loyalty with period of residence

	<u>Period of residence</u>					
	<u>Yr.</u>	<u>2 Yrs.</u>	<u>3 Yrs.</u>	<u>4 Yrs.</u>	<u>5 Yrs.</u>	<u>Total</u>
Loyal	34.7	34.3	13.9	8.6	8.6	245 (Row %)
Disloyal	0.0	31.1	27.7	21.7	19.6	235
Indeterminate	34.4	13.6	20.4	17.2	14.5	221
CHI-SQUARE=137.5 DF=8 SIG=0.0000 CRAMER'S V=0.313						

From the earlier discussion on socio-economic characteristics and temporal loyalty it may be expected that a similar pattern would emerge with regard to spatial loyalty. This is indeed the case (Table

9.18). Relatively more of the spatially loyal patients are in SECs 1 and 2 than is the case for patients not categorised as spatially loyal. Hence, the relationships alluded to earlier between SEC and the propensity to be dental patients and between SEC and the pattern of attendance not only have a temporal component but also a spatial one.

Table 9.17

Spatial loyalty and period of residence.

Period of residence

	<u>Yr.</u>	<u>2 Yrs.</u>	<u>3 Yrs.</u>	<u>4 Yrs.</u>	<u>5 Yrs.</u>	<u>Total</u>	
Sp.Loyal	35.4	29.2	11.5	13.3	10.6	113	(Row %)
Remainder	20.7	26.5	22.2	16.6	14.0	392	

CHI-SQUARE=14.6 DF=4 SIG=0.0056 CRAMER'S V=0.170

Table 9.18

Spatial loyalty with SEC

	<u>SEC1</u>	<u>SEC2</u>	<u>SEC3</u>	<u>SEC4</u>	<u>Total</u>	
Sp.Loyal	38.8	46.9	9.2	5.1	98	(Row %)
Remainder	24.1	39.9	20.6	15.3	731	

CHI-SQUARE=20.6 DF=3 SIG=0.0001 CRAMER'S V=0.157

The age distribution of patients, however, does show a marked difference between temporally and spatially loyal patients. Relatively few patients aged 21 to 34 are temporally loyal (Table 9.5). On the other hand spatially loyal patients are excessively clustered in this age-group (Table 9.19). Part of the explanation for this feature could be that many people in this age-group will, for one reason or another, notably marriage, leave the parental home to establish their own. Clearly, these people open themselves to the

possibility of being spatially loyal to their dentist.

Table 9.19

Spatial loyalty and age

	<u>Age-groups</u>						
	0-15	16-20	21-34	35-44	45-54	55+	
Sp.loyal	5.3	9.7	57.5	15.9	7.1	4.4	113 (Row %)
Remainder	7.1	10.6	37.1	18.6	13.6	13.0	856
CHI-SQUARE=20.8 DF=5 SIG=0.0009 CRAMER'S V=0.146							

Such an explanation may also help to account for the temporal nature of spatial loyalty. Once young couples have children it becomes important for dental care to be accessible and easily reached. A more sensible choice of dentist may thus be made and spatial loyalty given up. The importance of attending a dentist relatively close by is reflected in the questionnaire survey data (Table 9.20). Relatively more patients not classified as spatially loyal considered it 'very important' or 'fairly important' that their dentist be close to their home or work, than with the spatially loyal group. Approximately half this latter group felt that it was not important that their dentist be close by.

Table 9.20

Spatial loyalty and the importance of attending a nearby dentist.

	<u>V.imp.</u>	<u>F.imp.</u>	<u>N.imp.</u>	<u>Total</u>
Sp.Loyal	10.6	39.8	49.6	113 (Row %)
Remainder	17.4	46.6	36.0	852
CHI-SQUARE=8.6 DF=2 SIG=0.0136 CRAMER'S V=0.094				



## Conclusion

Though the data used in this study are not ideally suited to the purpose, they nevertheless provide evidence supporting the existence of 'geographic patient loyalty' and its effect of increasing the distance travelled for dental care. Time was shown to have a strong influence. As time increases following a residential move more and more patients cease being loyal and switch to another dentist more conveniently located. Age appeared to be an important influence. Young people seeking independence leave home thus exposing themselves to the opportunity of being 'loyal'. However, when they marry and have children it becomes more important to attend a dentist who is close by. Nevertheless, a hard core of patients appear to continue being loyal even after a considerable period of time.

For the dentist it is important to note that though patient loyalty does exist, it appears to be a relatively uncommon phenomenon, concerning approximately twelve per cent of patients. And this proportion declines over time as patients make more spatially rational choices. Thus new surgeries, especially in areas without existing surgeries, are not likely to be unduly influenced by potential patients remaining loyal to their current dentists.

Clearly a large number of questions remain to be answered: would a study specifically of geographic loyalty support the conclusions of this study?; what would be the effect of moving to an area without a dentist?, would it foster loyalty or encourage people to cease attending a dentist?. Answers to questions such as these could affect the distribution of dental care in urban areas. Further analysis of

the implications for dentists could encourage the movement of surgeries to new residential areas.

## Chapter Ten

### Capacity

Oberg (1976) has illustrated how surgery capacity in Sweden may influence a patient's choice of dentist. The purpose of this chapter is to build upon that work. To this end the theoretical significance of the capacity of facilities is considered. Following this a computer based model representing the theoretical role of capacity is developed. Finally, the model is used as an analytical tool to estimate the 'burden' of costs imposed by capacity.

### Capacity and theory

Central place theory is perhaps the best known theory in human geography, yet it offers little in the way of explaining spatial behaviour or spatial patterns. Its role is perhaps that of a normative model rather than a theory. Two of the key postulates on which it is based are:

- 1) suppliers of a good or service will locate wherever there is sufficient surplus profit to support an additional outlet.
- 2) consumers of a good or service will go to the nearest supply point to obtain it.

Also fundamental to the theory as we know it, is the assumption of an isotropic plain, where population, resources etc., are evenly distributed. The focus of this chapter is primarily on the second postulate.

Within central place theory it is argued that the cost of a good or service to a consumer varies with the travel cost he incurs to obtain it, so the consumer uses the nearest supply point. Although this hypothesis has been tested and found unsatisfactory in several studies, in general the nearest centre hypothesis has been shown to

be a reasonably good predictor of spatial behaviour, which nevertheless leaves room for other explanatory factors. A study by Clark (1968) whose purpose was to attempt to understand "the underlying orderliness of spatial behaviour which characterises intra-urban areas", found that only 46.8 per cent of meat purchases, 57.4 per cent of grocery purchases and 62.8 per cent of vegetable purchases were at the nearest centre to a respondent's home. Clark concluded that the nearest centre hypothesis was of weak explanatory power. Whilst these are far from 'total explanations' the fact that such large proportions of spatial behaviour could be predicted from a single postulate is surely testimony to its underlying validity

Using data on the grocery expenditure of a sample of rural residents in Iowa, Rushton, Golledge & Clark (1967) showed that the nearest centre hypothesis was most accurate when towns larger than 1200 inhabitants were considered. Over 52 per cent bought the majority of their grocery purchases in the nearest town larger than 1200 inhabitants. When other town sizes were considered the predictive accuracy of the hypothesis was lower, in some cases considerably so. For example only 10.5 per cent purchased their groceries in the nearest town larger than 16000 population. Rushton, et al, clearly thought this inadequate and proceeded to develop a model based on the willingness of consumers to travel certain distances to towns of certain sizes with better predictive accuracy.

The major concern of traditional central place theory has been the spacing of settlements and the shape and size of their hinterlands. In other words, the focus of interest has been on the spatial

patterns which arise from human behaviour. However, it is unrealistic to assume that the spatial pattern of supply points does not exert a feedback influence on spatial behaviour. To better understand the effect of this feedback it is necessary to consider the spatial pattern which is its source. It is not necessary to elaborate the implications of central place theory with regard to the spacing of supply points and the nature of their catchment areas; these are already well known. What is less well known is the implication of these for the 'capacity' of supply points. The capacity of a supply point is defined here as the maximum number of consumers who can be provided with the good or service from that supply point, within a given period of time.

When population is evenly distributed and hinterlands are of equal size, it is to be expected that the capacity of supply points will also be equal. This is simply because they each face the same volume of demand. If capacities were not equal, however, and demand was inelastic, some consumers would have to travel beyond their nearest supply point to obtain the desired good or service. Thus we see that, theoretically, capacity can exert an influence on the spatial behaviour of consumers. Central place theory would lead us to believe that consumers always go to their nearest centre in order to minimise their expenditure. Such an interpretation is 'permitted' by ignoring capacity as a constraint. It has been argued that, where capacity is unevenly distributed, some consumers must travel beyond their nearest centre. It would, therefore, seem not unreasonable to reformulate the nearest centre hypothesis as a 'nearest centre with spare capacity hypothesis'.

### The model

Having argued that the capacity of a centre is an important determinant of spatial behaviour this section discusses a model based on the revised hypothesis of the 'nearest centre with spare capacity', and considers some of its implications. A computer based algorithm was written to predict the spatial behaviour of dental patients based on the theoretical considerations outlined above. The predicted patterns output from the model are presented and then compared with actual patterns, the degree of correlation between the patterns acting as a measure of the 'realism' of the hypothesis.

The model is based on two assumptions, these are:

- 1) consumers will always attend the nearest centre with spare capacity;
- 2) demand is spatially inelastic, that is, it does not vary with distance.

The purpose of the model is to allocate demand to supply. In the present case the volume of supply and demand are derived from the SDEB data. Each patient recorded by the SDEB sample is assumed to seek dental care from his home enumeration district. Distances are measured from ED mid-points. Surgery capacity is set to the levels observed in the SDEB data. In this way the volumes of supply and demand, and their geographic distributions, incorporate the 'real world' situation. It also ensures that supply equals demand. Whether this is a realistic assumption is not known.

Information concerning the distribution of surgeries and their capacities and the number of consumers at each demand point are fed

in as data to the program.

The algorithm is iterative and in each iteration the following steps occur:

- 1) Thiessen polygons are formed around each surgery with unallocated supply. Thus, in each iteration demand is focused on the nearest surgery with spare capacity;
- 2) the total volume of demand within each Thiessen polygon is calculated;
- 3) within each polygon demand is allocated to supply on the following basis:
  - i) one patient is allocated to the surgery from each ED in turn. Thus, one unit of demand will have been allocated from all demand points before a second unit is allocated from any demand point. The order in which EDs are processed within the polygon reflects the order in which the SDEB data were collected. For any Thiessen polygon the order is, therefore, fairly random. However, to check that no unsuspected ordering was producing spurious results the order of processing was reversed. No major difference was observed between the output for this run and that for the standard run. In any case, the final output is largely constrained by the size of each Thiessen polygon and by the amount of demand allocated in each iteration;
  - ii) as demand is allocated the total amounts of demand and supply at each demand and supply point are reduced and a number of measurements are made. These include the distance travelled and the origin and destination of the allocation. From these,



the summary statistics for each iteration and for the complete program run are calculated;

- 4) the process of allocating demand to supply within a Thiessen polygon continues in this circular fashion until either all demand or all supply has been allocated. The program then moves on to the next Thiessen polygon where the same process is conducted. When all theissen polygons have been treated in this manner the iteration is complete.

The program continues to subsequent iterations if neither total demand nor total supply have been allocated. New Thiessen polygons are calculated for each iteration, to take account of those supply centres and demand points where supply or demand has been totally allocated. When either total supply or total demand have been allocated the program stops.

It is considered that this algorithm adequately represents the theoretical consideration outlined above. Consequently, output from the program represents predictions, or hypotheses, which can be tested for validity simply by comparison with the real world situation. The output to be used for this analysis consists of the following:

- 1) a measure of the total distance (kilometres) travelled in the system as a whole;
- 2) the mean distance travelled in the system as a whole;
- 3) distance decay data based on half-kilometre distance zones;

4) the mean distance travelled by units of demand from each of the squares in the grid covering the residential areas of Edinburgh.

The concept of capacity, when used as a constraint, as in the present instance, suggests the notion of definite and fixed limits. Yet it may be considered by some that the capacity of a supply point, instead of being fixed would simply reflect the volume of demand seeking the good or service at that point. However, it is unlikely that the capacity of dental surgeries would be very responsive to variations in demand, for the following reasons.

Most dentists today, schedule their patients by means of an appointment system. The result is that for any given day there is a maximum number of patients who may be treated. In addition the work of a dentist contains a large physical element and requires considerable effort and concentration. Consequently, the capacity of a dentist's surgery is influenced by his physical stamina.

However, perhaps the most important influence on surgery capacity is the number of dentists who practice there. It is likely that the number of dentists at any surgery will change only slowly, for two reasons. First, modern dental equipment represents a considerable financial investment, and each dentist requires his own.

Consequently, the high cost of dental equipment precludes the ability to respond quickly to variations in demand by installing another dentist (or removing one!). The second reason is the constraint imposed by the capacity of the surgery premises. Only a given number of dentist<sup>s</sup> may be accommodated at any one surgery.

To evaluate the effectiveness of the capacity constraint in raising the level of explanation it is necessary to compare two theoretical situations with the corresponding situation in reality. The first theoretical situation is that where patients attend their nearest surgery. This equates with the nearest centre hypothesis of central place theory. It is possible to determine the pattern of movement that would arise if all patients attended their nearest surgery by using the computer program written for this analysis with the capacity constraint removed. This is achieved simply by making the capacity of each surgery large enough to accept any possible volume of demand. The pattern of spatial behaviour arising when the capacity constraint is activated constitutes the second theoretical situation.

A number of measures of actual spatial behaviour will be used, the first being the total distance travelled by all patients in the system (Table 10.1) The total distance actually travelled was 10,454 kilometres whereas that predicted by the nearest centre hypothesis was only 2,491 kilometres. Thus, distance to patients' nearest surgeries accounts for 24 per cent of the total distance travelled in the system. Clearly there is scope for considerable improvement in the 'nearest centre hypothesis'. When capacity is considered as a constraint on the spatial behaviour of dental patients such an improvement is provided. The predicted total distance travelled within the system is then 6,941 kilometres, or 66 per cent of the actual total - an improvement of 42 per cent. The conclusion can therefore be drawn that, in this instance, capacity is an important explanatory variable with regard to the spatial behaviour of dental

patients.

Table 10.1

Comparison of actual distances travelled with those predicted by the model.

	<u>actual</u>	<u>predicted</u>	<u>nearest</u>
sum	10,454	6941	2491
mean	2.4	1.6	0.6
median	1.7	0.8	0.5

---

Implications of the model

As the first step to a consideration of the distribution of costs and benefits conferred by the distribution of capacity between surgeries, it is of some interest to map the predicted and actual distances travelled.

Data concerning patients from each enumeration district were aggregated to the half-kilometre square framework and the mean actual and mean predicted (with capacity constraint on) distances calculated for the patients of each square. The results are shown in Figures 10.1 and 10.2. Clearly, there is some spatial relationship between the two distributions with the shortest values being in the city centre and the longest in the suburbs.

It is illuminating to consider two further aspects. First, there is the difference between predicted and actual distances (Figure 10.3). Most often the difference is positive, indicating the actual mean distance for patients in a particular cell is greater than the predicted value. However, there are occasions when, on average, patients in a cell do not travel as far as predicted. Comparison of

Figure 10.1 The distribution of actual mean distances travelled

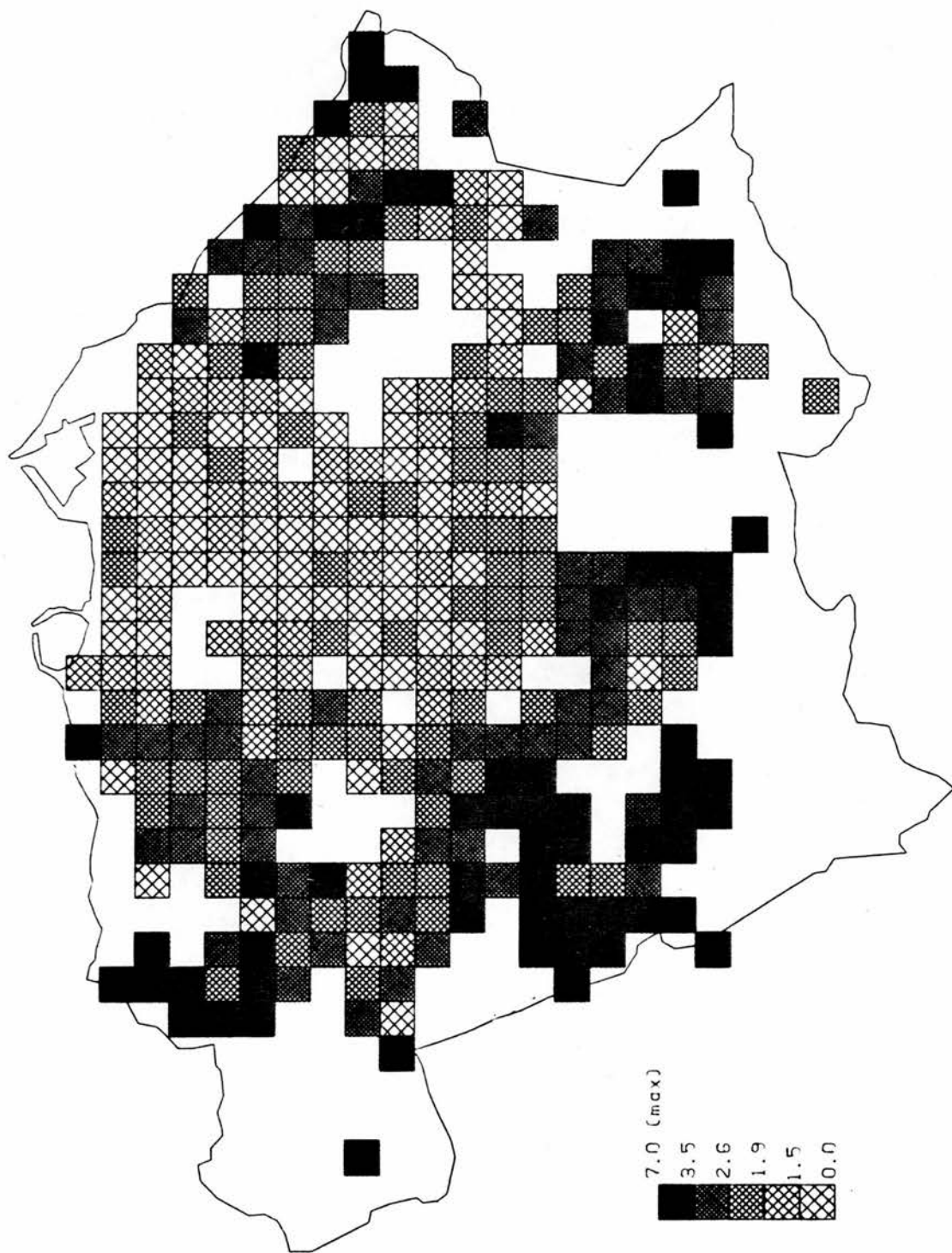


Figure 10.2 The distribution of predicted mean distances, with the capacity constraint on

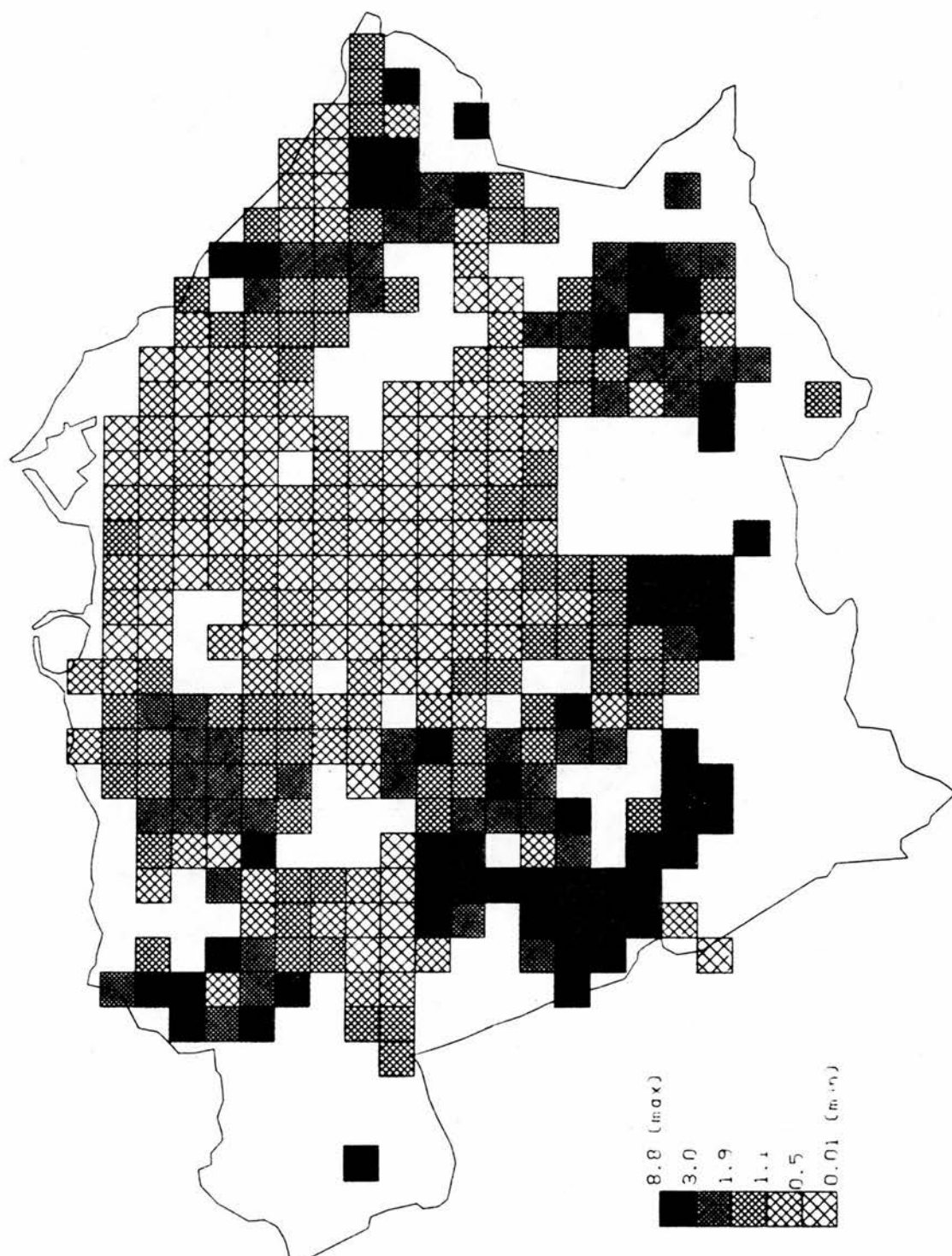
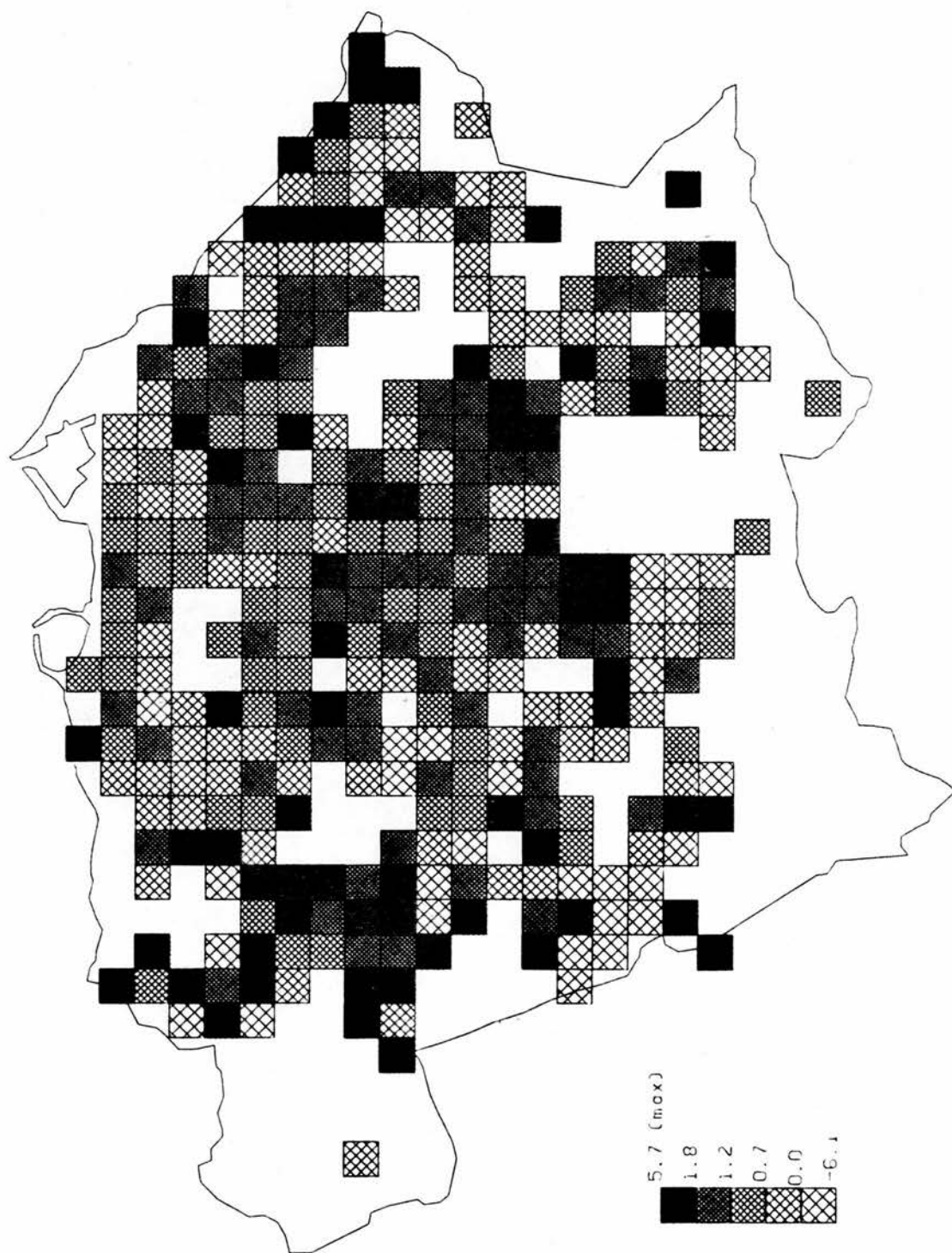


Figure 10.3 The difference between mean predicted and mean actual distances travelled



this pattern with those in Chapter Five concerning the distribution of SEC does reveal similarities. It would appear that patients from 'lower status' areas, especially council estates, tend to make relatively restricted spatial choices. This produces behaviour similar to that predicted by the capacity constraint model. Conversely, patients from 'higher status' areas tend to make rather more widespread spatial choices than those predicted by the model. This difference between the actual and predicted distances represents the effect of choice on spatial behaviour, and will be termed 'excess' distance.

The second aspect is the difference between the distance to the nearest surgery and the predicted distance (Figure 10.4), which in a very real sense represents the 'cost' imposed by capacity forcing some patients to travel beyond their nearest surgery.

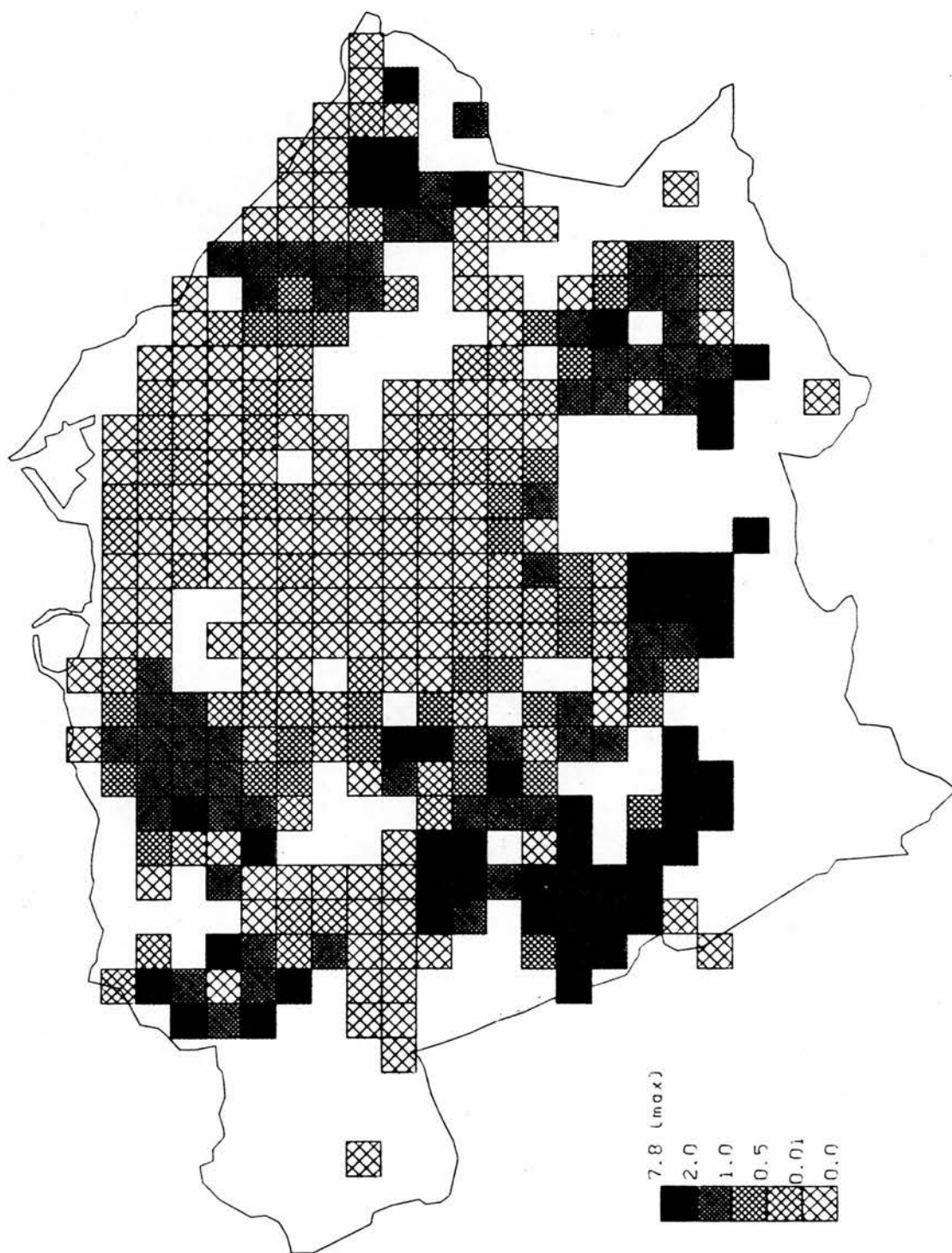
It is clear, from Figures 10.1, 10.2 and 10.4, that the spatial distributions of actual distance, predicted distance, and 'cost' show a high degree of similarity, with higher values being found in the suburbs and low values in the centre. These distributions reflect the combined effects of surgery distribution and the distribution of capacity amongst surgeries. Essentially, the maldistribution of capacity vis-a-vis demand, is exacerbating the effect on distance travelled caused by the concentration of surgeries in the city centre.

#### The distribution of costs and benefits

Having considered the implications for distance travelled imposed by



Figure 10.4 The difference between mean predicted distance and the distance to the nearest surgery



the capacity of surgeries we now turn to the patients who bear the costs and benefits. Questionnaire respondents were allocated to 'quartiles' of the distributions shown in Figures 10.1, 10.2 and 10.4, on the basis of their home location. This then enabled a cross-tabulation of patients with type of area.

It would appear that the burden of predicted distance falls more on the very young and lower social-status patients, whilst those in SECs 1 and 2 and the older age-groups gain the relative benefits of shorter distances (Tables 10.2 and 10.3). It is plain that relatively more patients in the upper quartile of predicted distance are aged 0- 15 and relatively fewer are in the older age-groups than is the case for the lowest quartile. Similarly, the upper quartile has relatively more patients in SECs 3 and 4 and relatively less in SECs 1 and 2 than has the lower quartile. The sex of patients was not statistically associated with predicted distance.

Table 10.2

The age distribution of patients in each quartile of the distribution of mean predicted distances

<u>age-group</u>	<u>predicted distance quartiles</u>			
	1	2	3	4
0-15	5.9	6.7	9.0	15.7
16-20	12.8	11.0	16.9	12.3
21-34	43.3	35.0	31.0	39.5
35-44	15.3	17.5	16.0	12.1
45-54	10.3	13.8	12.5	10.8
55+	12.4	16.0	14.6	9.6
total	556	326	432	511

CHI-SQUARE=622.3 DF=15 SIG=0.0000 CRAMER'S V=0.107

This picture is reinforced by data concerning the 'cost' due solely

to the capacities of surgeries. The age and sex of patients showed a significant relationship with 'cost' (Tables 10.4 and 10.5). As with predicted distance the cost imposed by surgery capacities can be seen to fall relatively more heavily on the young than the old.

Table 10.3

The distribution, by SEC, of patients in each quartile of the distribution of mean predicted distances.

<u>SEC</u>	<u>predicted distance quartiles</u>			
	1	2	3	4
	%	%	%	%
SEC 1	28.8	34.0	26.3	26.0
SEC 2	44.0	35.9	40.5	38.8
SEC 3	16.3	20.5	17.3	19.0
SEC 4	10.9	9.7	15.9	16.2
-----				
total	459	268	346	420

CHI-SQUARE=18.5    DF=9    SIG=0.0302    CRAMER'S V=0.064

Table 10.4

The percentage of patients in each 'distance cost' category who are in each age group

<u>age-group</u>	<u>distance cost quartiles</u>			
	1	2	3	4
0-15	6.2	10.2	8.4	14.7
16-20	12.2	13.6	14.6	13.3
21-34	41.0	39.0	31.6	40.0
35-44	15.6	16.9	16.2	12.3
45-54	12.4	7.9	12.9	10.5
55+	12.7	12.4	16.4	9.3
-----				
total	630	177	513	505

CHI-SQUARE=48.1    DF=15    SIG=0.0000    CRAMER'S V=0.094

Given the congruence of the distributions shown in Figures 10.1, 10.2 and 10.4 it is to be expected that the burden of 'actual' distance

travelled will fall on the same groups as do cost and predicted distances. This is in fact the case, though only the age of patients is significantly related to actual distance travelled (Table 10.6).

Table 10.5

The percentage of patients in each distance cost category in each sex

<u>sex</u>	<u>distance cost quartiles</u>			
	1	2	3	4
male	36.7	48.3	37.3	37.9
female	63.3	51.7	62.7	62.1
-----				
total	627	176	512	501
CHI-SQUARE=8.4 DF=3 SIG=0.039 CRAMER'S V=0.068				

Table 10.6

The percentage of patients in each actual distance category in each age group.

<u>age-group</u>	<u>actual distance quartiles</u>			
	1	2	3	4
	%	%	%	%
0-15	6.5	8.3	10.0	13.7
16-20	13.0	15.2	14.7	10.4
21-34	43.5	39.9	28.5	38.0
35-44	13.0	14.6	18.5	14.3
45-54	12.1	9.3	12.0	13.0
55+	11.9	12.8	16.2	10.6
-----				
total	478	494	400	453
CHI-SQUARE=46.2 DF=15 SIG=0.0001 CRAMER'S V=0.092				

Thus, the combined effects of the distribution of surgeries and of surgery capacity imposes a cost that is felt somewhat more by the young than the old. To a large extent this conclusion is to be

expected given the distributions in Figures 10.1, 10.2 and 10.4 because most of the city's new housing stock, both private and council, is to be found in the suburbs. It seems reasonable to assume that young married couples will gravitate to those areas, and thus account for the relative prevalence of young children there. The flight to the suburbs of the population has not been matched by a similar flight of dentists.

### Conclusion

The theoretical significance of capacity as an important factor in the accessibility of facilities was discussed. Following this a model was developed to represent spatial behaviour as predicted by the revised 'nearest centre with spare capacity hypothesis'. Output from the model showed considerable improvements in the accuracy of predictions over the performance of the earlier 'nearest centre hypothesis'. This same output was also used to determine the distribution of 'distance cost' and 'excess distance' or choice. Finally, questionnaire responses were used to illustrate the characteristics of patients receiving the costs and benefits imposed by surgery capacity.

However, it should be borne in mind that the purpose of this chapter was simply as an exercise to establish whether surgery capacity could influence distances travelled by dental patients. The mechanism described by the algorithm of the model may not bear a close relation to 'real world' forces. Consequently, it cannot be concluded that capacity does influence distance travelled, but the evidence

presented here does strongly suggest that in many parts of the city, capacity is a constraint which may well force patients to use dentists outside their home areas. Hence capacity is probably a significant factor in explaining the distances travelled and the choice of dentist made by patients from those areas, particularly the suburbs.

## Chapter Eleven

### Conclusions

Having presented the substantive part of the study, it is appropriate now to stand back and try to provide an overall assessment of its effectiveness as a research project. Accordingly, this chapter deals with three main topics:

- a) a summary of findings;
- b) methodological criticisms;
- c) further research.

Before moving on to this assessment it is important to recall that the study stemmed from two general interests: the location of facilities and the use of medical care. In the event the emphasis has been on describing how dental patients make use of the general dental services available to them. As such the conclusions from this study are more relevant to questions of facility location than to an assessment of medical care provision. Nevertheless, planners of medical care delivery, particularly of dental care, may find the study pertinent.

#### Summary of results

The objective of the study was to consider the spatial behaviour of dental patients in Edinburgh. In particular, the main question addressed concerned reasons why not all patients use their nearest surgery. As a prelude to answering this question, Chapters Four and Five, on supply and demand, described the setting within which the spatial behaviour occurred. In Chapter Four the distribution of surgeries was shown to have important implications for the accessibility of dental care, in that dental surgeries in Edinburgh are concentrated in the city centre. As a result suburban residents



have relatively poor access to dental care. However the capacity of surgeries partly offset<sup>s</sup> this effect, suburban surgeries tended to be relatively large. Only in the centre, it was suggested, would small surgeries find sufficient demand to offset any fluctuations in demand for their services. Consequently, suburban residents face relatively large amounts of capacity in their nearest surgeries.

Not only is the distribution of surgeries clustered in the city centre, it also favours the 'higher status' residential areas. Large council housing estates tend to be relatively isolated from dental care, though they may be served by 'lone' surgeries. In contrast areas with large numbers of people in SECs 1 and 2 had good accessibility to surgeries.

Actual distances between patients' homes and surgeries were examined in Chapter Six. Geographically, the distances indicated that suburban patients travelled longer distances than patients from the city centre. Yet distances travelled to suburban surgeries were less than those for central surgeries. Age was shown to be an important factor in this pattern. Suburban patients aged 20 or less travelled much shorter distances than older patients. Thus suburban surgeries seemed better able to 'catch' younger patients. Perhaps because older patients were more likely to work or shop in the city centre and use nearby surgeries.

The distance decay curve showed that though most patients chose a dentist fairly close to their home, some were willing to travel quite long distances to attend the dentist of their choice. Patients in

SECs 3 and 4 showed a stronger desire to attend surgeries close to home than did patients in SECs 1 or 2.

Distance decay exponents were calculated for each SEC. In general the pattern that emerged from these did not match that derived from the general distance decay curves. Regression lines 'fitted' to various transformations of the data tended to underpredict at the upper left-hand end of the line, the part where errors in prediction would be most important because most people travel short distances. Consequently, it was suggested that such exponents might not be suitable for inclusion in interaction models.

From Chapters Seven, Eight, and Nine a general conclusion is that 'mobility', different 'origins and destinations', and 'patient loyalty' are factors that can partly 'explain' why not all patients attend their nearest surgery.

Car ownership was shown, in Chapter Seven, to be an important aspect of the mobility of dental patients. The three major modes of travel were car, bus and walking. These were associated with considerable differences in the distances travelled and the travel time required. Walkers travelled the shortest distances and car users the longest. Bus travellers journeyed similar distances to car users, but took much longer. If patients didn't have access to a car they had to travel by bus if they wanted to exercise a wide spatial choice of dentist, similar to that of car users.

Different population sub-groups showed different levels of car

ownership and ability to drive. Age was obviously important here. The highest levels of car ownership were for those aged 21 to 64. It was argued that stage in the lifecycle was a strong influence on this (particularly legal considerations and earning capability). For the SECs there was a clear gradation of car ownership and ability to drive with decreasing 'status'. Marginally more males than females were from car-owning households.

Thus different groups had different levels of access to cars. However, where similar modes of travel were used similar spatial choices were exercised. Therefore it seems that 'access to cars' is a major influence on the distribution of costs and benefits (perhaps rather than sex, SEC or age). This in turn would seem to be influenced by income.

In Chapter Eight it was shown that home location was the most frequent origin and destination for journeys to the dentist. However it was not the only location. Work and shopping were also important. Three types of flow were discerned: 'homeward', 'circulating', and 'shopping'. Many patients returned home after visiting their dentist. Thus, attending their dentist was the last in a series of activities, i.e. 'homeward behaviour'. On the other hand some patients returned to their origin location after seeing their dentist, particularly those coming from work or school. This was deemed 'circulating' behaviour.

Because shopping is a time consuming affair and because most dentists use an appointment system it was considered that shopping trips would

be difficult to complete before attending their dentist. Not surprisingly, it turned out to be the case that most shopping trips occurred after attending the dentist, and after leaving home, a pattern referred to as 'shopping behaviour'.

An interesting aspect of different origins and destinations is the possibility that patients may try to minimise the distance they travel. In other words they would minimise the deviation from a straight line between their origin and destination. The closer their surgery was to that straight line, the more they were minimising distance. Two significant results were obtained. First, it was possible, using geometric techniques, to identify a group denoted as distance minimising, who did in fact travel the shortest distances between their origin and destination even though their origins and destinations were furthest apart. Secondly, the group identified as not being distance minimisers had the shortest straight line distance between their origin and destination, and yet travelled the longest distance between them. Perhaps their direct distance was so short they did not mind making relatively long detours.

The concept of patient loyalty was explored in Chapter Nine. In essence the idea was that the loyalty of patients who have moved away from their dentist would remain loyal to him and thus travel relatively long distances. Though the data were not ideally suited to the task it was possible to identify a group of patients who were spatially loyal to their dentist. In addition, the data showed a temporal component to this loyalty. As time increased from the date of the residential move the number of spatially loyal patients

decreased. A possible explanation for this is that patients initially know more about the area they have left than the area they have moved to. Consequently they at first continue to attend their previous dentist. However as they learn more about dentists in their new home area and as costs of travelling to their previous dentist become more apparent, they eventually decide to change to a more conveniently situated dentist. This explanation is particularly appropriate because the bulk of spatially loyal patients were aged 21-34. These patients were shown to be highly mobile, possibly because many would marry. Most young married couples move to a home of their own, possibly in a different area. However when children appear on the scene it becomes very important, particularly for the wife, to use a local surgery.

Chapter Ten undertook a theoretical appraisal of whether the distribution of surgery capacity could influence the distances travelled by patients. The basic notion was that where surgery capacity was inadequate to meet demand some patients would have to travel beyond their nearest surgery. Consequently, an amendment to the 'nearest centre' hypothesis was proposed, to make it the 'nearest centre with spare capacity' hypothesis. This was then modelled by a computer program.

Output from the model was compared with the 'real world' data collected by this study. On the basis of predicted distances the revised hypothesis was concluded to be a better representation of reality than the original. Further comparisons showed that the 'cost' of sub-optimally distributed surgery capacity was borne mainly by the

young.

### Methodological Criticisms

It is difficult to be critical of a piece of work that represents a considerable investment of one's time and effort, especially because an author can only see his work from the 'inside'. However there are two criticisms that should be levelled at this thesis. First, and most significantly, the scope of the project was too broad and secondly, there are sins of omission.

This work has taken a fairly broad view of the spatial behaviour of patients in that an attempt has been made to consider several factors which might be relevant in explaining a patient's choice of dentist and the distance he travels. Much of the existing literature on this and related topics takes a narrower view by considering only one or two factors, such as social class or mobility. Having adopted a broad approach it is now possible to assess its advantages and disadvantages.

One of the main advantages is that it has been possible to show how the factors of 'mobility', 'origin and destination', 'patient loyalty' and 'surgery capacity' relate to social class and age, and to the nearest centre hypothesis, a major linking theme for the whole study. Had a narrower approach been taken, it might have been possible to examine some of these factors in greater depth but it would not have been possible to link them so fully to the other factors.

However, the factors of 'mobility', 'origins and destinations', 'patient loyalty' and 'surgery capacity' have tended to remain separate avenues of exploration to a large extent. Since each of the four was shown to have several facets, a thorough analysis of their interrelationships would require a larger study than the present one. Each avenue, nevertheless, has yielded some interesting results and insights and it is hoped that the present work may provide a springboard for more thorough analyses of these interrelationships. The relationships between mobility and patient loyalty and between mobility and the origins and destinations of patients might be particularly interesting for further study. By making their relationships with age, SEC and distance travelled clearer it is also hoped that the present work may help to provide a clearer social and spatial framework for further exploration of the interrelationships between the four factors.

It is worth noting that mobility, 'origin and destination', patient loyalty and capacity may be relevant to explaining the consumer behaviour of other services. The influence of loyalty, capacity and 'origin and destination' has apparently received little attention in the general literature on spatial behaviour, so in this respect the present work may be seen as a contribution to the wider field of spatial behaviour as well as to the spatial analysis of the use of medical care.

By sampling from the whole city it was possible to consider surgeries and patients in something like the full geographical context of the urban system of which they are part. The disadvantage resulting from

such a broad areal cover of the study area was that in some instances disaggregation spread the data thinly over a large number of grid cells, which made it difficult to examine some topics as stringently as might have been desired or to reach definite conclusions on some questions - particularly the spatial elasticity of demand.

Sins of omission, alluded to earlier, mostly concern the fact that only one perspective has been presented, a relatively objective view of the spatial behaviour of patients. No analysis of the attitudes and opinions of patients or dentists has been presented. Within the format of the study this would have been impossible. Neither time nor resources would have permitted such an extension of scope. Nevertheless, one would expect that such an analysis would be of value to planners and dentists particularly, as well as being of academic interest.

#### Further research

Perhaps one of the most interesting tasks that could follow this work would be to assess the viability of selected locations for the establishment of new surgeries. This would be the practical application of the ideas that have been considered by this thesis. As such it would consider the influence that distance, mobility, origins and destinations, and surgery capacity exert on the demand attracted by individual surgeries.

Along these lines one question that should receive careful attention concerns the viability of dental surgeries situated in council estates. Of particular interest to dentists is whether such



surgeries can attract enough demand. The evidence from this study would suggest that surgeries on council estates would be more attractive to local residents than more distant surgeries, possibly because of relatively low levels of car ownership.

Because of the lower propensity to seek dental care by residents of council estates, one issue should be to establish a minimum threshold size of estate that could support a surgery. In this study two of the surgeries surveyed were situated on council estates. The experience of these dentists and others like them should be assessed so that others may benefit from it. Should it become common practice to locate a dental surgery on a council estate the improvement in local dental health could be quite significant. In Chapter Four the brief discussion of the uptake of dental care provided evidence from the literature showing that it was a function of the accessibility of that care. Part of the reason why 'lower status' groups in the population make less use of the available dental care could be that it is not near enough for them.

Another related issue that should receive attention is whether dental attendance habits change when a surgery is sited on a council estate. That is, do local residents start to attend more frequently.

Also of practical value would be a study of why dentists establish new surgeries where they do. Information gleaned from such a study would be of immense value to local health authorities trying to control the distribution of poor dental health.

Reasons why patients choose the dentists they do should also be examined in some detail. A proper understanding of these would, of course, have practical application. Improving the flow of information to individual sub-groups could raise their uptake of dental care and thus improve their dental health.

Having shown that 'mobility', 'origin and destination', and 'patient loyalty' are associated with the distance travelled, and that 'surgery capacity' could be, two problems appear for location-allocation modellers. The first is how to incorporate these factors into a location-allocation model. Direct specification of the effects of these factors on distance travelled is required. Secondly, there is the question of whether such elaboration of location-allocation models is 'worth the effort'. It could be that using empirically derived distance decay parameters as a 'black box', containing all the relevant factors, is sufficient to obtain reasonably good solutions. Theoretical analyses of alternative approaches could provide an indication of the most productive avenue to take.

Finally, conclusions obtained by this study are particular to Edinburgh. A similar work in another city would indicate the generality of these conclusions. In particular, Edinburgh is a well 'dentisted' city and it could be that the 'spatial behaviour of dental patients' in a city less well supplied with dentists could differ from that described by this study.

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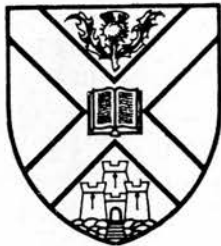


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## Appendices



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School of the Built Environment

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SURVEY ON THE PATTERNS OF USE OF DENTISTS IN EDINBURGH

Dear Sir/Madam

This questionnaire is being used to collect information for a study on the geographical pattern of use of dentists in Edinburgh. Several other dental surgeries are also being used in this survey.

Generally, I would like to know which people use which dentists, how visits to the dentist fit in with other daily activities and what people's attitudes to dental care are. The success of this study therefore depends on your co-operation in completing this questionnaire. All answers will be treated in the strictest confidence, being used for research purposes only. It is hoped that the results of this study will form the basis of a doctoral thesis.

Fully completed questionnaires will, of course, make the greatest contribution to this study. Would you, therefore, please try to complete your questionnaire, even if this means doing so after you have seen your dentist, it will only take a few moments of your time.

Thanking you in advance.

Yours faithfully,

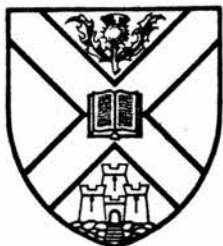
John D. McCalden

<p style="text-align: right;">CODE NUMBER <span style="border: 1px solid black; display: inline-block; width: 40px; height: 20px; vertical-align: middle; text-align: center; line-height: 20px;">1</span></p> <p>Dentist's Name _____</p> <p>WHEN ANSWERING THE FOLLOWING QUESTIONS PLEASE RING THE APPROPRIATE NUMBER OR WRITE YOUR ANSWER IN THE BOX PROVIDED</p>	<p>1-5</p> <p>7-10</p>
<p>(A) What is your: <u>Sex</u> 1. Male 2. Female</p> <p style="margin-left: 100px;"><u>Year of Birth</u> 19 <span style="border: 1px solid black; display: inline-block; width: 40px; height: 20px; vertical-align: middle;"></span></p> <p style="margin-left: 100px;"><u>Marital Status</u> 1. Single 2. Married</p> <p><u>Address</u> _____ <u>Postcode</u> _____</p>	<p>12</p> <p>14-15</p> <p>17</p> <p>19-24</p>
<p>(B) At what time is your appointment? <span style="border: 1px solid black; display: inline-block; width: 100px; height: 20px; vertical-align: middle;"></span></p>	<p>26-29</p>
<p>(C) Where were you <u>immediately</u> before coming to the dentist?</p> <p>1. at home 2. at work 3. shopping 4. at school</p> <p>5. elsewhere</p> <p>If not at home please give full address of place you were at _____ <u>Postcode</u> _____</p>	<p>31</p> <p>33-38</p>
<p>(D) At what time did you leave to come to the dentist? <span style="border: 1px solid black; display: inline-block; width: 100px; height: 20px; vertical-align: middle;"></span></p> <p>When did you arrive? <span style="border: 1px solid black; display: inline-block; width: 100px; height: 20px; vertical-align: middle;"></span></p>	<p>40-43</p> <p>45-48</p>
<p>(E) How did you travel to the dentist?</p> <p>1. walk 2. cycle 3. bus 4. car 5. motor-cycle</p> <p>6. other</p> <p>If you travelled by bus what number(s) did you get? <span style="border: 1px solid black; display: inline-block; width: 40px; height: 20px; vertical-align: middle;"></span> <span style="border: 1px solid black; display: inline-block; width: 40px; height: 20px; vertical-align: middle;"></span></p> <p>If you travelled by car did you have difficulty finding a parking place? 1. Yes 2. No</p>	<p>50</p> <p>52-55</p> <p>57</p>
<p>(F) How many cars does your household have? <span style="border: 1px solid black; display: inline-block; width: 30px; height: 20px; vertical-align: middle;"></span></p> <p>Do you have a driving licence? 1. Yes 2. No</p>	<p>59</p> <p>61</p>
<p>(G) Where are you going when you leave the dentist?</p> <p>1. home 2. to work 3. shopping 4. to school</p> <p>5. elsewhere</p> <p>If not going home please give full address of your destination _____ <u>Postcode</u> _____</p>	<p>63</p> <p>65-70</p>
<p>(H) How long is it since you finished your last course of dental treatment?</p> <p>1. 6 months to 1 year 4. 2 to 5 years</p> <p>2. 1 to 1½ years 5. over 5 years</p> <p>3. 1½ to 2 years</p>	<p>72</p>

(I) How many other courses of dental treatment have you had during the past two years?	<input type="checkbox"/>	74
(J) How many times during the past two years have you attended a dentist for a check-up and not required further treatment?	<input type="checkbox"/>	76
(K) Generally, do you attend the dentist: 1. for a regular check-up 2. for an occasional check-up 3. only when having trouble		78
(L) How long is it since you first came to this dentist? 1. less than one year                      3. between two and five years 2. between one and two years        4. over five years		80
CARD NUMBER 2 - CODE NUMBER <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> 2		1-5
(M) Why did you choose this dentist? Was it because this dentist is: 1. near your home 2. near your work or because 3. you were recommended to come here		
(N) If you were recommended, were you recommended by: 1. a relative                      3. a friend 2. a neighbour                  4. a workmate		9
(O) How many other dentists have you been to in the past five years?	<input type="checkbox"/>	11
(P) For how many years have you lived at your present address? <input type="checkbox"/> <input type="checkbox"/> What was your previous address? ----- Postcode -----		13-14 16-21
(Q) Would you continue coming to this dentist if he, or you, moved to a more distant part of Edinburgh? 1. Yes 2. No		23
(R) If this practice closed, where would you go for dental care? 1. to a dentist who was recommended to you 2. to a dentist near your home 3. to a dentist near your work 4. to another dentist you already know of		25
(S) How important to you is it that your dentist be fairly near to your home or work? Is it: 1. very important    2. fairly important    3. not important		27

<p>(T) What is the reason for this visit to the dentist? Is it:</p> <ol style="list-style-type: none"> <li>1. for a check-up</li> <li>2. for treatment following a check-up</li> <li>3. because you are having trouble with your teeth</li> <li>4. for treatment following 3</li> </ol>	29
<p>(U) How effective do you think regular attendance at the dentist is in controlling dental disease? Is it:</p> <ol style="list-style-type: none"> <li>1. the most important factor</li> <li>3. not very important</li> <li>2. an important factor</li> <li>4. not at all important</li> </ol>	31
<p>(V) Do you have dentures? 1. Yes 2. No If yes, do you have:</p> <ol style="list-style-type: none"> <li>1. a full set of dentures</li> <li>4. a full lower set</li> <li>2. a full upper set</li> <li>5. a partial lower set</li> <li>3. a partial upper set</li> </ol>	33 35-36
<p>(W) Is this a visit for private or N.H.S. treatment?</p> <ol style="list-style-type: none"> <li>1. private</li> <li>2. N.H.S</li> </ol>	38
<p>(X) What is your occupation? _____</p>	40-41
<p>(Y) If you are a married woman what is your husband's occupation, if you are still at school what is your father's? _____</p> <p>Are you a nursing or expectant mother <ol style="list-style-type: none"><li>1. Yes</li><li>2. No</li></ol></p>	43-44 46
<p>(z) How many other dental surgeries do you know of in Edinburgh? <input type="checkbox"/></p> <p>Please give their locations _____</p>	48 50-69

Thank you for answering this questionnaire, I hope it has not caused you too much inconvenience. Please check that you have answered all the appropriate questions, and then hand it back to the receptionist.



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I am a postgraduate research student in the Department of Geography at Edinburgh University undertaking work which will form the basis of a doctoral thesis. My area of interest concerns the spatial pattern of use of general dental services in Edinburgh. In order to pursue my interest I require to conduct a questionnaire survey of dental patients at a sample of surgeries throughout the city. Your co-operation on this matter, by permitting me to use your surgery for a week-long survey in the near future, is requested and would be greatly appreciated.

I must stress at this point that absolutely no burden will be placed upon yourself and little, if any, on your practice routine.

The questionnaire I propose to use will be self-administered, and as such is quite short and does not pry too deeply into patients' private affairs. A copy is enclosed for your inspection. In earlier, pilot surveys, patients were completing the questionnaire in 5 to 6 minutes. During these pilot surveys it was arranged that as each patient arrived at the surgery the receptionist give them a questionnaire and pen. The patient then completed the questionnaire in the waiting room, prior to being seen by his dentist. This arrangement worked admirably and is the one which, with your permission, I would use at your surgery. Apart from delivering and collecting the questionnaires and pens I would not be present and thus would not be 'in the way'. Once the questionnaires were analysed I would supply you with an analysis of the results.

Being a geographer I am, of course, interested in the spatial aspect of things. Consequently, when sampling dentists, I divided Edinburgh into ten areal units and drew a random sample from each. It is in this way that your surgery was selected and is the reason for my writing to you now. The success of my research depends on each of these areas being represented in the survey. In this I am dependent on your granting of my request, which, would mean a great deal to me and would also, hopefully, contribute to our understanding of how urban services are used.

If this request meets with your approval I would welcome an opportunity to meet you, in order to discuss the details of administering the questionnaire. To this purpose I enclose a stamped-addressed envelope for your reply.

Looking forward to meeting you

Yours sincerely

John D McCalden

### APPENDIX 3

The derivation of socio-economic classes follows the precedent set by Robson (1969), whereby the seventeen socio-economic groups used by the census are aggregated into four classes. Table 1 shows the nature of the aggregation used in this study. This classification differs from that of Robson's in that there is a fifth class, to cater for households enumerated in the census where the 'head' is a student, a woman less than sixty years old or somebody who did not fit into any other category and who has never been economically active.

# CLASSIFICATION OF SOCIO-ECONOMIC GROUPS INTO SOCIO-ECONOMIC CLASSES.

## SOCIO-ECONOMIC

### CLASS

### SOCIO-ECONOMIC GROUPS ( economically active or retired )

### CHARACTERISATION

1	1-employers and managers, large establishments 2-employers and managers, small establishments 3-professional - self-employed 4- " - employees 13-farmers - employers and managers	professional
2	5-intermediate non-manual 6-junior non-manual	non-manual/ intermediate
3	8-foremen and supervisors 9-skilled manual 12-own account - ( non professional ) 14-farmers - own account	foremen/skilled/ self-employed
4	7-personal service workers 10-semi-skilled manual 11-unskilled manual 15-agriculture workers 16-armed forces 17-inadequately described occupation  (never active)	low skill
5	students, women less than sixty, others	other